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Increasing the Power

THE REMODELED STATION OF PEORIA GAS & ELECTRIC CO., PEORIA, ILL.

THIS STATION IS PART of the system of the Central Illinois Electric Co., and serves to supply not only power and light for the city of Peoria, as well as heat for the central business section, but is also interconnected with stations at Pekin, Farmington, Elmwood and Cuba, towns near Peoria, and is the source of supply for East Peoria and for a number of coal-mining plants.

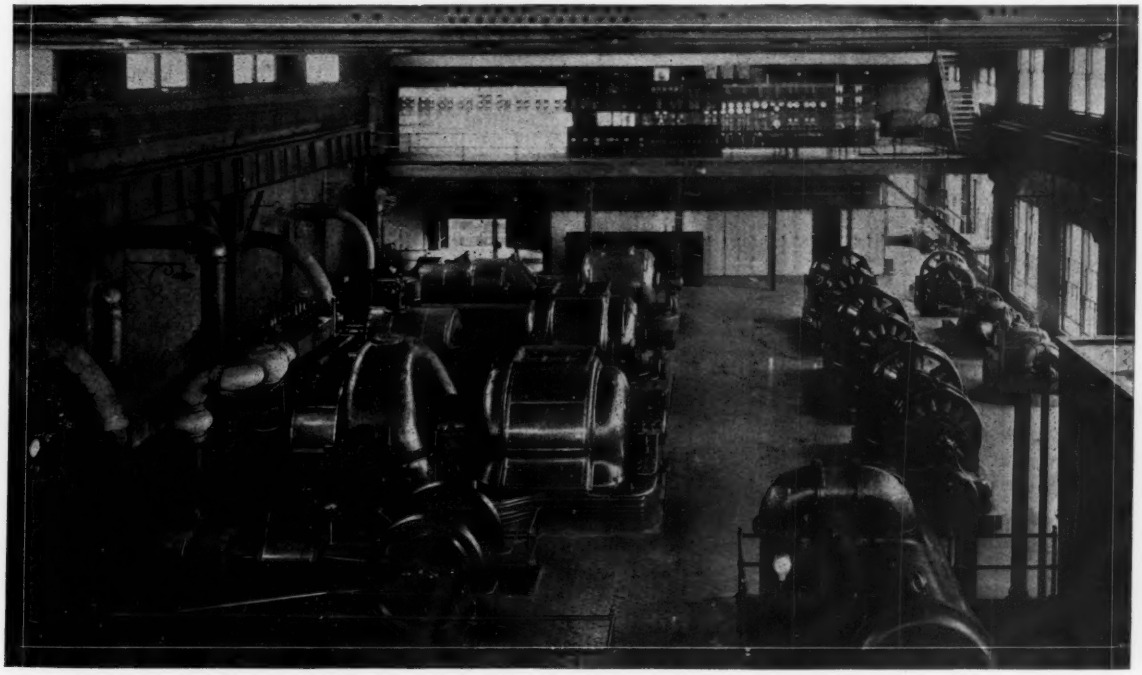


FIG. 1. VIEW OF THE TURBINES AND EXCITERS IN THE ENGINE ROOM OF PEORIA PLANT FROM THE EAST END

It is a development from the early days of electric lighting, when the reciprocating engine and the belted generator were the rule; and it is only in this last remodeling that the belted unit has entirely disappeared from the plant. Two cross-compound, reciprocating engines, direct connected to generators, are still used as reserve units, but the main power of the station is now furnished by turbo-generator units, the latest member of the family being a 5000-kw. machine.

Building space has, of course, been increased according to the needs of the plant, and in the final remodeling, the roof has been raised bodily, and the side walls increased in height. The building is of steel frame construction, with large windows and with walls of tan-colored pressed brick, and because of being near the river, it is placed on a heavy concrete foundation, with piling used where necessary. The roof is of the flat steel truss type, with gravel covering and without turret. The boiler house is of the same construction, but has above it, at the present time, coal bunkers which have recently been installed in connection with the elevating

and conveying system, and there is also a turret roof above the boilers proper, for ventilation. A fire wall, with steel fire doors, separates boiler and engine rooms.

The plant includes, besides the buildings mentioned, a small oil house and substation for raising the voltage to high pressure, and a water treating installation, with softener house and settling tower.

The engine room is arranged with the turbine floor above the street level and the pumps and condensers in the basement, which has its level at about the level of the street. The switchboard is at one end of the engine room, with the bench board and vertical panels for control of the generators and distribution, on the first gallery, and a system of voltage regulators on a second gallery. Transformers are located in the basement, to which all lines from the switchboard are carried, leaving the basement underground.

At the other end of the engine room is located an open space for pumps, and in this space, also, the Curtis vertical turbine. Pumps and condensers for the new units are, for the most part, in the open pit, about the middle of the turbine room, and running crosswise of the room.

Current from the main generating units is supplied at 2300 volts, and is transmitted at this voltage to the residence districts, where it is stepped down by district transformers. It is also passed, at this voltage, to the substation building, where it is stepped up to 13,000 volts for transmission to distant substations. For lighting the business district, current is transformed down to 220 volts, and distributed on the 3-wire, 220-110-volt system, and for power in the business district, motor generators are used, furnishing direct current at 525 volts.

Arc lighting is furnished on the series system by the use of tub transformers and voltage regulators, which change the constant potential current into constant current distribution. The distribution to the arc light system is carried underground by means of 12-conductor cables, which are carried in the street conduits and rise outside of the business district to pot heads on the distributing poles. This use of the 12-conductor cables has greatly simplified the handling of the arc lighting installation, both inside and outside the station. All conductors, whether from machines or switchboard, are carried to the basement, and are there led on cable shelves for connection above the basement, and for the distributing mains going outside of the station, are carried in trenches to the distributing vault which is outside the foundation of the building. Tile conduits are placed in the building walls and adjacent, to carry the leads from the basement up to the switchboard, and nests of conduit are used where necessary for carrying the leads about the station.

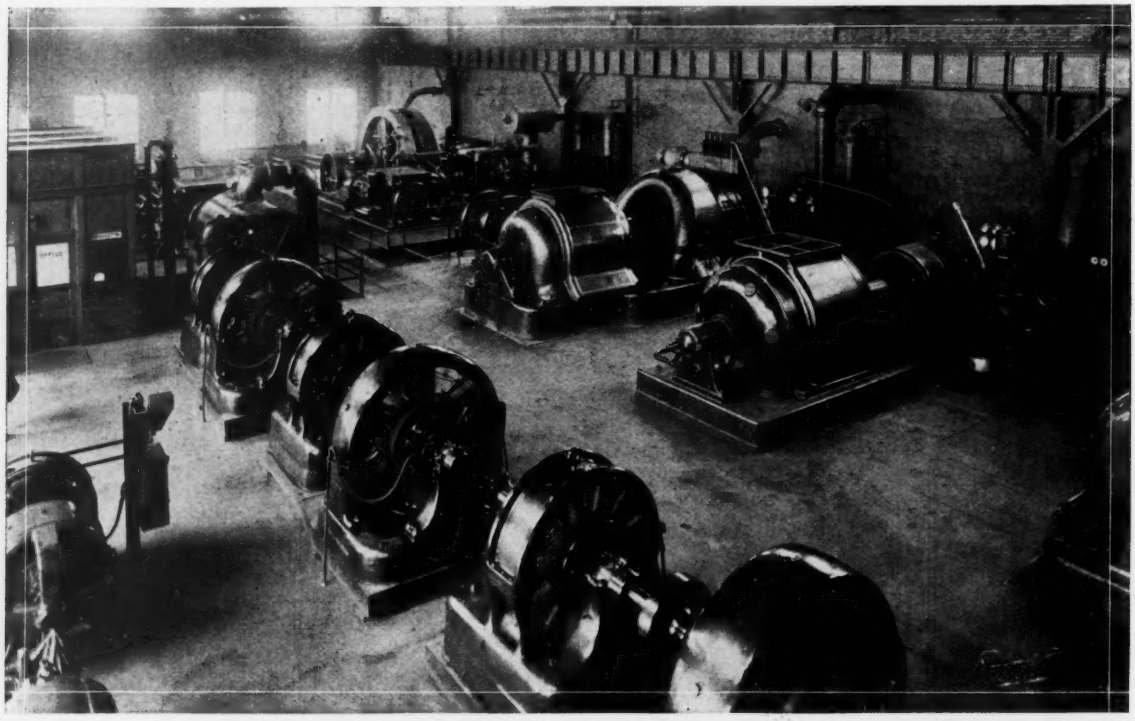


FIG. 1A. GENERAL VIEW OF THE ENGINE ROOM FROM THE SWITCHBOARD GALLERY

Generating units are 6 in number. Two of these are reciprocating engines, cross-compound, double eccentric Corliss, driving multipolar alternators, direct connected. These run at 100 r.p.m., giving 60-cycle current, 3-phase, and one of them furnishes 201 amp. at normal rating, while the other furnishes 150 amp.

During a former remodeling and enlarging of the station, a Curtis vertical turbine was installed, with condenser in the base. This is now used as a stand-by, or for extra heavy peak loads.

The most commonly used equipment is the 3 latest units installed, one an Allis-Chalmers of 1500-kw. capacity, at 80 per cent power factor, running at 1800 r.p.m., and exhausting into a Wheeler surface condenser; the second unit is an Allis-Chalmers 3000-kw., at 80 per cent power factor, running at 1800 r.p.m., and operated through a large part of the year noncondensing. It is from this unit that most of the steam is derived for the central heating system. The third and latest unit is a Curtis 5000-kw. turbine, running at 1800 r.p.m., and

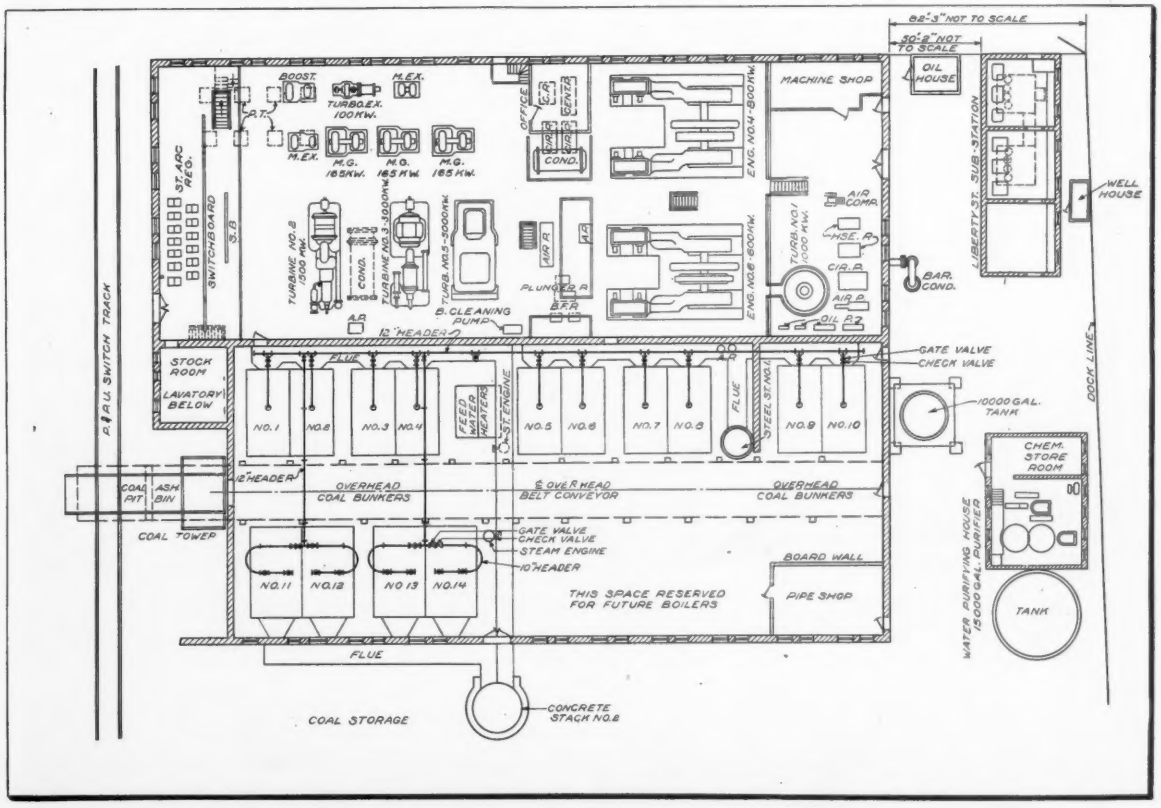


FIG. 2. PLAN OF PLANT, SHOWING BUILDINGS AND ARRANGEMENT OF MACHINERY

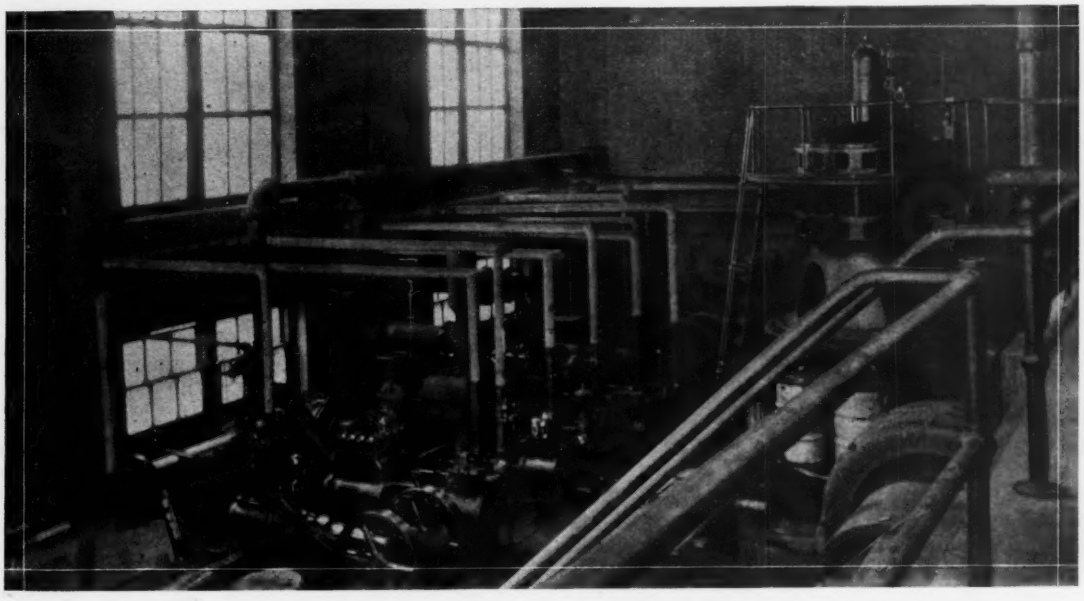


FIG. 3. PUMPS AND CURTIS VERTICAL TURBINE IN EAST PIT

furnishing 1570 amp. This has a condenser installed below it, and arranged so that the No. 2 unit can also exhaust into this condenser, if desired, or any one of the 3 units can be run noncondensing and furnish steam to the central heating system, as indicated in the piping layout.

The reciprocating engines exhaust to a Worthington surface condenser, located above the central pump pit, and served by a Deane, of Holyoke, vacuum pump.

The water for the station comes from the Illinois River, which flows past the station. That used for cooling is pumped direct through the condensers and returns to the river by gravity. That for house use and boiler feed is sent to the purifying system, and after softening and filtering, it is returned to the house service by one pump, and to the boilers through a feed water heater by a system of pumps. Between the feed water heater and boilers, there is also a unit installed, economizer with fan, which is connected between the boiler and the economizer to increase the draft.

Pump installation in the central transfer pit takes water from the mains which flows along the station on the east side, near the floor level. The steam main for these pumps is carried in a loop above the pumps at the sides, going from the main heater in the boiler room around to the supply line, which runs to the reciprocating engine units. The exhaust line for the pump pit is overhead, and is carried down the center of the pit, connecting up to the feed water heater. Intake from the river comes along the north side of the station, and is connected up with the pumps, which go to the purifying system and to the boilers and condensers, at such points as may be necessary.

A number of pumps are used for furnishing the cooling water for condensers, these are all connected into a single main, which passes along by the north end of the condensers and has branches taken off. The cooling water pumps are located, for the most part, at the north end of the pit, and include a Worthington 3-rotor centrifugal, driven at 1475 r.p.m., by a 180-hp. Kerr Economy steam turbine; 2 duplex Worthington pumps, each 12 by 15 by 15 in., and an Allis-Chalmers 16-in. centrifugal pump, with capacity of 5000 gal. per min., under 32-ft. head, and at 1100 r.p.m., driven by 100-hp. Kerr turbine. Near the center of the pit is a small duplex Worthington pump for furnishing wash water for cleaning the boilers, and at the south end are 2 vertical feed water pumps, a centrifugal pump and a duplex horizontal, outside packed plunger type, all used as may be necessary to pump water into the feed lines.

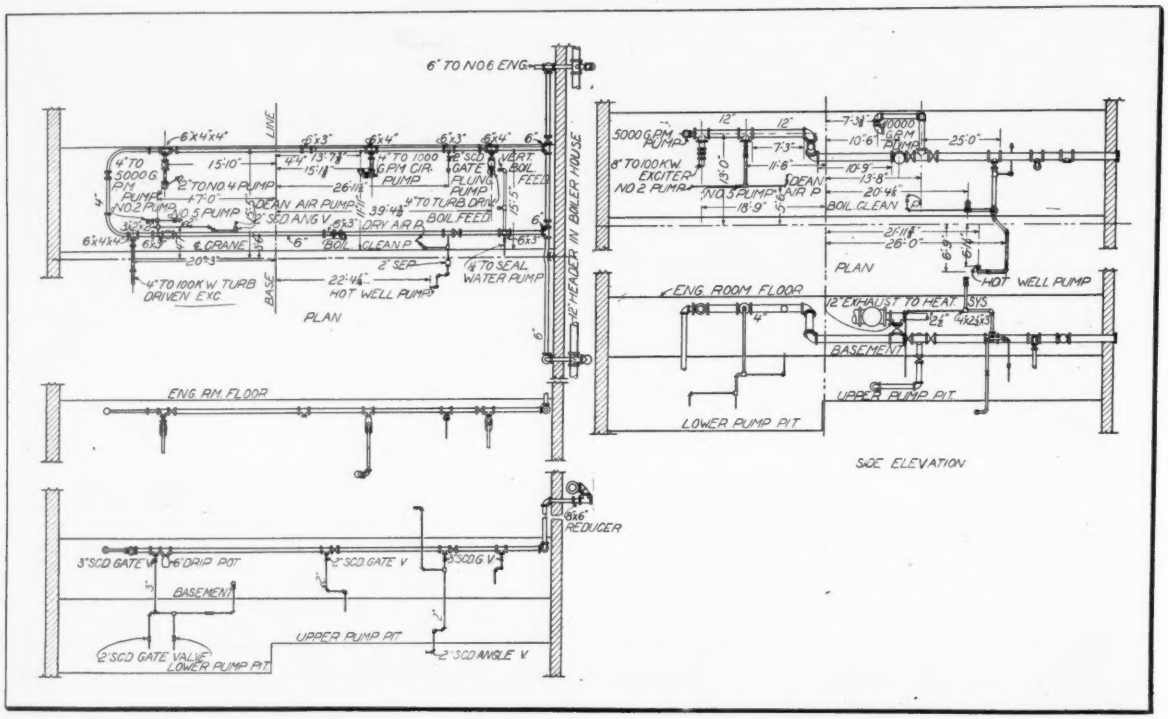


FIG. 4. STEAM AN EXHAUST CONNECTIONS OF PUMPS IN CENTRAL PIT

At one side of the large condenser for the 5000-kw. unit, is a 4-in. Wheeler hot well pump, driven at 1600 r.p.m., by a 15-hp. Kerr turbine. In the east end pump pit are located the pumps for the Curtis vertical turbine unit, including 2 Worthington duplex pumps for keeping the step bearing supplied with oil, and a Worthington dry vacuum pump. The condenser is of the barometric type, located outside the building. This pump pit contains, also, pumps for supplying water to the purifying plant, a Worthington duplex, 12 by 17 by 15 in., also a Worthington duplex pump, with a Deane as relay, for supplying house and wash water, a Union Steam Pump Works air compressor to supply air for cleaning the generators, and some other small apparatus.

Steam is supplied to the generating units by long bend connections from the main steam header which is located in the boiler room. The exhaust is carried to an underground main, which passes through the basement near the boiler room wall, and is connected to the condensers, to the district heating main, or through a relief valve to atmospheric exhaust. A Cochrane oil separator is placed on the exhaust of each unit, to remove the oil before the steam passes to the heating system.

The amount of steam fed to the heating system is recorded by a flow meter manufactured by the Industrial Instrument Co., which registers this amount in accordance with the difference in pressure through a nozzle, on the principle of the Venturi water meter.

For the regulation of each turbine, a gage board is placed near it, having a Westinghouse synchroscope and wattmeter, and a set of Ashcroft gages, which show inlet, exhaust steam pipe and oil pressures. By means of these, any irregular action of the turbine can be readily detected. The boiler pressure is carried ordinarily at 160 lb., the pressure in the heating mains at 15 lb., and the pressure on the condensers at 29-in. vacuum.

To supply exciting current for the generating units, 3 exciter units are installed at the north side of the turbine room. One of these is a turbine-driven unit, consisting of an Allis-Chalmers generator, furnishing 800 amp., at 125 volts, and driven at 1800 r.p.m., by a 100-kw. Kerr turbine. The other 2 units are motor driven, one of them having 165-hp., General Electric, synchronous motor, driving a 100-kw. generator, at 900 r.p.m. The other is a 120-hp., General Electric, 3-phase induction motor, driving a 125-kw. generator, at 600 r.p.m. All of these are so connected to the switchboard that they may be used to furnish exciting current for any one of the generator units, or they may furnish direct current for special work and for charging the storage battery, which is installed in the basement for operating remote control switches.

FIG. 5. COAL TOWER, ECONOMIZER ROOM AND STACK; MAIN STATION BEYOND THE COAL TOWER

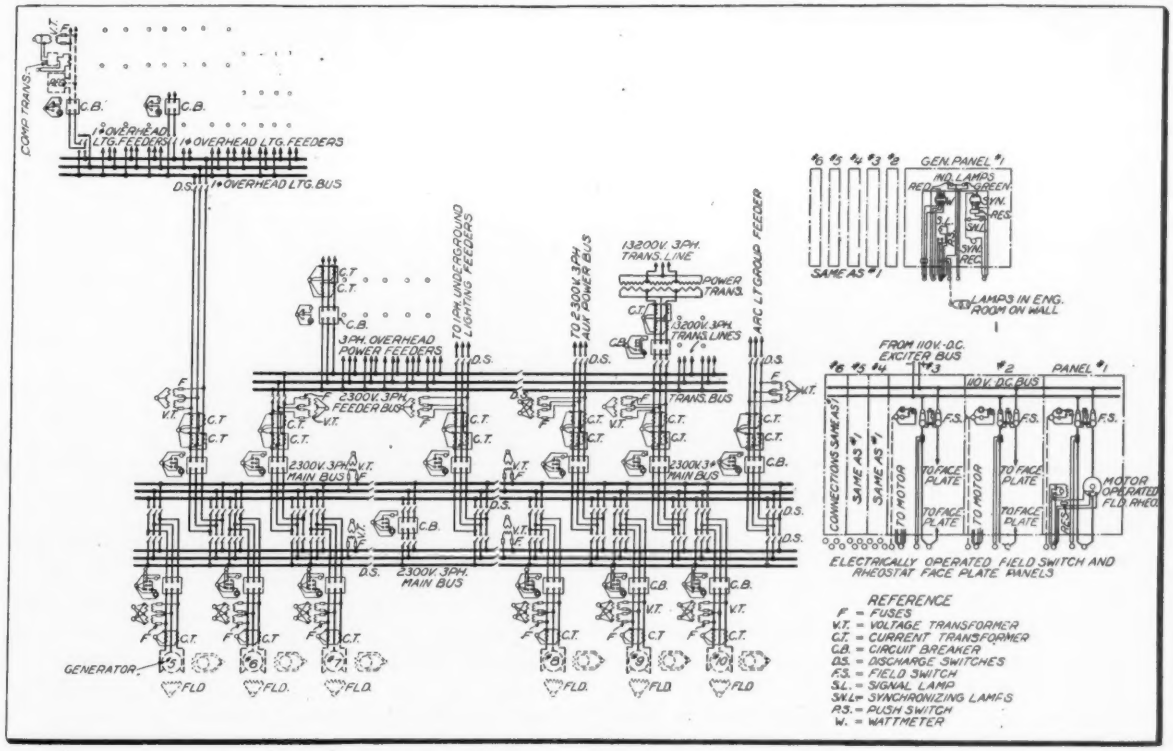


FIG. 6. ELECTRICAL CONNECTIONS OF STATION

Near these exciter units are installed the motor generator units for furnishing the 525-volt direct current. These consist of synchronous motors of 220 hp., each

taking 2300-volt, 60-cycle current, and driving at 600 r.p.m., the direct-current generators, which furnish 261 amp. each, at from 525 to 575 volts, the generators being over-compounded to take care of drop in the feeder lines.

Feed water, after passing through the Kennicott purifying and softening system, is drawn by the boiler

FIG. 7. BENCH BOARD AND METERS

feed pumps from the settling tank and pumped to a Hoppes feed-water heater and purifier, from which it passes to a Sturtevant economizer. The boiler equipment is placed on 2 sides of a center and consists of 12 250-hp. Geary water-tube boilers and 4 400-hp. All are equipped with chain grate stokers, made by the Green Engineering Co., and fitted with sprinkler pipes

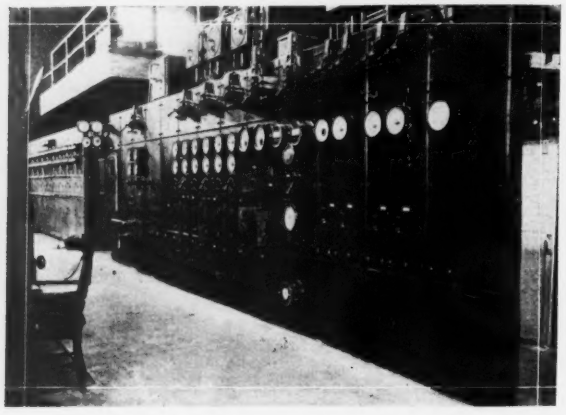


FIG. 8. PANELS FOR MOTOR GENERATORS AND EXCITERS. ARC LIGHT PANELS IN BACKGROUND

above the hoppers for wetting down the coal. The stoker grates are engine driven from a counter shaft, duplicate engine equipment being installed.

The draft, as already stated, is controlled by an induced draft fan placed between the boilers and the economizer. From the economizer the gases pass to 2 stacks, one of these a Weber concrete chimney, as shown in the view of the coal conveying system, the other a guyed steel stack, which is directly behind the concrete stack.

This coal handling system, which is illustrated, was installed by the Jeffrey Mfg. Co., and consists of a 1½-ton clam-shell bucket, operated from the tower, which takes coal direct from the flat cars and drops it into a crusher. From this crusher it goes to a belt conveyor, which runs lengthwise of the boiler house, and deposits the coal wherever desired in the hoppers which are above the boilers. From these hoppers, the coal drops by gravity through chutes to the stokers.

The blowoff from the boilers is taken through a main at the back into a blowoff well, and thence to the river, the control being by means of a gate valve on each boiler blow-out, followed by a Scully Everlasting blowoff valve.

Control of the generation and distribution is carried to the switchboards on the first gallery. The resistances

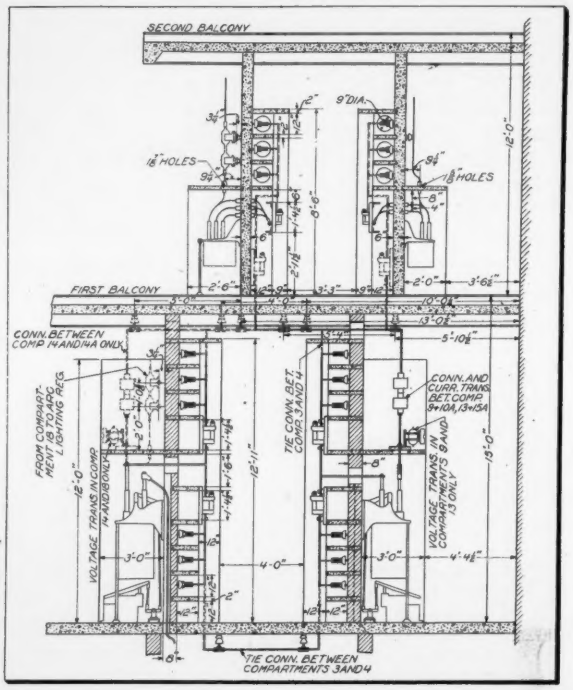

SECOND BALCONY
FIRST BALCONY
9"DIA.
18" HOLES
CONN. BETWEEN COMP. H AND H A ONLY
FROM COMPART. NEXT TO ADC LIGHTING REG.
VOLTAGE TRANS IN COMP. H AND H A ONLY
TIE CONN. BET. COMPS. 3 AND 4
CONN. AND CURR. TRANS. BET. COMPS. 9 + 10 A, 13 + 15 A
VOLTAGE TRANS IN COMPARTMENTS 9 AND 13 ONLY
TIE CONN. BETWEEN COMPARTMENTS 3 AND 4

FIG. 9. CONSTRUCTION OF BUS BAR COMPARTMENTS IN REAR OF SWITCHBOARD

for the generator fields are located on the main floor, and handle other remote control motors from the bench board, but all other apparatus is placed, either on the switchboard galleries, or in the basement. The bench board, which is located at the front of the gallery, controls the high voltage generation and distribution, including the main generating units, substation transformers, and the high voltage transmission lines. The vertical panels, which face the bench board, control the current for the business district, the exciters, motor generators, and the railway feeders.

At the south end of the gallery is located the special arc panels, with the constant current regulators placed behind them, staggered in 2 rows facing each other, thus minimizing space to the greatest possible degree.

The tub transformers for the arc light circuits, as well as the potential transformers for the business section lighting, are located in the basement of the station, and the step-up transformers for long distance transmission are located in the substation. Potential regu-

lators for keeping the voltage on the lines in the business district constant, are on the second gallery above the main switchboard.

Behind the vertical panels of the switchboard are located the bus bar compartments, and the oil brake switches. These bus compartments are built up of rein-

FIG. 10. ARC CIRCUIT REGULATORS AND BUS BAR COMPARTMENTS

forced concrete slabs, barriers being made outside the plant and set in place to make the desired structure. The reinforcing stays are ¼-in. rods of No. 8 wire, and all necessary bendings in the barriers were formed in when they were built. This reduces the amount of work required in the station, in building up of the bus compartments, to a minimum, and greatly increases the rapidity of installation.

FIG. 11. VOLTAGE REGULATORS IN SECOND GALLERY

Covers for the front of the compartments are made out of asbestos board, with edges stiffened by reinforcing strips, and where inspection is desirable, a wire glass panel in the upper end. These boards are hung from the top by hooks, which permit of ready removal, and which also permit the bottom of the board to swing outward in case of the blowing of a fuse or other cause which results in heating the air in the compartment.

Lighting for the station is by means of large tungsten lamps, most of them running from the bus bars which supply the light to the business district. There is, however, provision for emergency supply to about ⅓ of the lights from the storage battery.

Convenience in handling substation construction, and the eliminating of all appearance of temporary installation, has been the end sought in the remodeling of this station, and it has been reached. The company and its engineers are to be congratulated on the successful conclusion of a task which has been more than ordinarily difficult, because of the variety of service supplied, the fact that a large territory depended primarily on this station for service, and the entire rearrangement of switchboard necessary in order to bring the plant up to the ideals of the engineers. The present remodeling has been based on possible future development to a considerably larger capacity, without the occasion to make any changes except the addition of boiler capacity and of further steam turbine units in place of reciprocating engine units, if this is deemed desirable.

Study of the Missouri

A SYSTEMATIC study of Missouri River and its tributaries is being carried on by the United States Geological Survey. Considering the varied character of the streams of the Missouri River basin and their great economic importance for irrigation, power, and other purposes, the investigation is one of the highest importance.

Ten States of the Union are drained in part by Missouri River. Rising at the Red Rock Lakes, at an elevation of 6700 ft. above sea level, this stream descends through the Rocky Mountains and emerges on the broad prairie land a few miles below the city of Great Falls, Mont. From that point it is accounted a navigable stream with an easy grade, and in passing through the Dakotas and along the borders of Nebraska, Kansas and Iowa it receives the flow of great tributaries, so that as it crosses the State of Missouri and joins the Mississippi a short distance above St. Louis, it becomes one of the large rivers of the world.

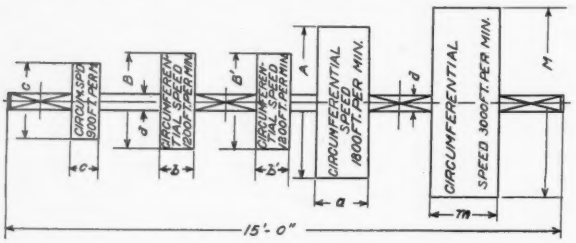
On Shoshone River in Wyoming, is located the Shoshone dam, the highest structure of its kind in the world, 328 ft. from foundation to capstone. This structure was erected by the Government to impound water for irrigation on the arid lands in the valley of Shoshone River below. Another great structure of a similar kind is located in Wyoming, on North Platte River, which joins the Missouri near Omaha, Neb. This is known as the Pathfinder dam, and was also erected by the Government to impound water for use in the irrigation of lands in Wyoming and Nebraska. Another notable engineering structure in the drainage basin of the Missouri River is the Belle Fourche dam, erected across the river of the same name in South Dakota by the Government to impound water for irrigation. This dam is an earth embankment 155 ft. high and 1 1/5 miles long, containing 1,600,000 cu. yd. of earth fill. This is the largest earth dam in existence.

Copies of Water-Supply Paper 306 may be procured upon application to the Director of the Geological Survey, Washington, D. C.

Some Power Transmission Economics

SOLUTIONS OF SOME SHAFTING PROBLEMS. BY REGINALD TRAUTSCHOLD

PRACTICALLY every factory, whether it be devoted to the production of machinery or of what may be termed industrial goods, or simply to the production of power, requires the distribution of the power generated at the engine to the various sources of consumption. That is, there is usually a concentrated point of power production from which the mechanical energy must be distributed to various machines, etc. If electrical transmission of power is not employed, and frequently, even in conjunction with electrical transmission, systems of line shafts are necessary to which power in relatively large quantities is delivered and from which power in lesser quantities is taken by individual machines or other consumers. This ordinarily requires the installation of systems of shafting with bearings, collars, pulleys, etc., for delivering the power to the machines in suitable quantities and correct proportion, frequently, if pulleys and belts are employed, necessitating a multiplicity of various sizes of pulleys to attain the correct belt speed at the various machines or tools.


CIRCUM. SPD 900 FT. PER M
CIRCUMFERENTIAL SPEED 1200 FT. PER MIN
CIRCUMFERENTIAL SPEED 1800 FT. PER MIN.
CIRCUMFERENTIAL SPEED 3000 FT. PER MIN.
15'-0"

SHAFT SPEED	d	HORSEPOWER TRANSMITTED BY & DIMENSIONS OF PULLEYS. HP	M	m	HP	A	a	HP	B	b	HP	B'	b'	HP	C	c
190 R.P.M.	4 7/16"	150	60"	22"	72	48"	17"	30	30"	11"	30	30"	11"	18"	24"	9"
380 " "	3 15/16"		30"	22"		24"	17"		15"	11"		15"	11"		12"	9"
570 " "	3 3/16"		20"	22"		16"	17"		10"	11"		10"	11"		8"	9"

TYPICAL LINE SHAFT LAYOUT

SHAFTING

SUCH A problem naturally permits a great number of solutions as far as obtaining the required belt speeds, etc., is concerned and just as obviously all possible arrangements cannot be equally economical, particularly when the number of different standard types of bearings, pulleys, shafting, etc., that may be satisfactorily employed is taken into consideration. The economics of the problem, then, is of considerable importance to every factory, and it will be the object of this discussion to treat such matters in a manner that will clearly emphasize certain errors in design that are unfortunately common to a large proportion of installations.

Taking as a concrete example, one that is typical of almost any factory employing belt drives, it will be assumed that 150 hp. is to be delivered to a line shaft by a main belt traveling 3000 ft. per min., and that 72 hp. is required by a machine or group of machines at a belt speed of 1800 ft. per min., 2 deliveries of 30 hp. each, at a belt speed of 1200 ft. per min., and the balance of 18 hp. is required at a belt speed of 900 ft. per min.

The belt speeds thus arbitrarily chosen are typical of many plants and usually allow of no great variation, the speed of the main belt being economical—more economical than any lower speed and but little less economical than higher speeds which would necessitate the use of pulleys of such large size as to make their use frequently impractical—and the other speeds being fixed by the requirements of the standard equipment of the power-consuming machines. Fixing the belt speeds in this manner is usually quite feasible and has the advantage of greatly simplifying the correct choice of transmission equipment, line shafts, etc. Nevertheless, it is in failure to solve just such simple problems, that the more commonly encountered mistakes are found.

The revolutions, speed of the line shaft required depend upon the sizes of pulleys employed, and could be almost any number, could be high, slow or medium; but, for all practical purposes, it may be assumed that 190 r.p.m. would represent a slow-speed line shaft, 380 r.p.m., a medium-speed and 570 r.p.m., a high-speed line shaft. The higher the speed of the line shaft, the lighter the shaft required for the transmission of the given power and the cheaper; other conditions, however, may make it advisable to use a larger and heavier shaft revolving at a slower speed, so that each of the 3 speeds of line shaft will be considered from an economic standpoint.

Reference to Chart I in the Practical Reference Tables, which gives the horsepower capacity of various sizes of high-grade steel shafting at 100 r.p.m., shows that, to handle 150 hp. at the line shaft speeds assumed, a 3 15/16-in. shaft would be required at 190 r.p.m., a 3 3/16-in. shaft at 380 r.p.m., or a 2¾-in. shaft at 570 r.p.m., the horsepower capacity of shafting varying directly with the speed of rotation.

Chart II gives the comparative cost of high-grade steel shafting—the base of comparison being the cost of a 1-in. shaft, which is taken as unity per foot—from which it is seen (Example 1) that the difference in cost between the large, slow-speed shaft and the small, high-speed one, is nearly 240 per cent, the large shaft being the costlier. For practical purposes, the cost of the shaft may be considered as also including the cost of the necessary collars, as such accessories do not add much to the cost of the average line shaft, any increase also being virtually proportional to the cost of the shaft. At the present market price of high grade steel shafting, the difference in cost of 15-ft. shafts, 3 15/16 and 2¾ in. in diameter, respectively, amounts to about $10.30, a very appreciable item if many such shafts are employed, but also a misleading item, for other economies may completely subordinate such a saving.

EXAMPLE I

Required the comparative cost of 15-ft. line shafts, 3 15/16, 3 3/16 and 2¾ in. in diameter, respectively.

Diam. shaft	Comparative Cost Per foot	Per shaft
3 15/16 in.	16.00	240.00
3 3/16 in.	9.40	141.00
2 3/4 in.	6.75	101.25

Ten dollars and thirty cents would represent not much more than 1/10 of one per cent of the cost of power that the line shaft would transmit during a year of 308 8-hr. working days; however, an amount that could easily be exceeded by failure to secure economical transmission of power, failure that might be due to uneconomical proportioning of the pulleys permitting the unnecessary slippage of belts, etc. In fact, true economy can be secured only by a consideration of all conditions affecting the question of power transmission and a careful analysis of the cost of various available equipments. Other economies will be analyzed in subsequent discussions, all of which will bear directly on the important and common problem of transmitting power efficiently by the employment of the most economic apparatus. Certain economies, such as that which has been shown to be possible in shafting, may occasionally have to be sacrificed in order to gain greater economies, and such economic wastes will be pointed out when possible.

The accompanying charts of horsepower capacity, comparative costs, etc., will not only serve as the basis upon which to figure the cost of equipment, but should prove of practical value to any factory or power house operator as a means by which the approximate cost of the equipment described may be readily ascertained and the most economical adopted. All that is required for their use as accurate price lists, is the actual cost of a particular piece of equipment, and knowing this, the cost of any other standard piece can be easily secured from the charts. For instance, the present market cost of 1-in., high-grade steel shafting, is about 8 cents a foot, so that the cost of any other size of shaft is easily obtained by reference to Chart II.

The typical lineshaft layout illustrated herewith will serve as an example of the conditions usually encountered and so will be further referred to during the consideration of equipment pertaining to belt transmission of power.

Heating and Ventilating Large Buildings*

PRESSURE SYSTEMS; HEATERS AND PUMPS USED IN FORCED HOT WATER CIRCULATION. BY CHARLES L. HUBBARD

MENTION has already been made of increasing the temperature of the water in the system above that commonly carried in the ordinary open-tank arrangement, where its theoretical limit is 212 deg., and its practical limit about 200 deg., while 180 is probably nearer the maximum temperature actually carried in the average gravity system. The temperature at which the water may be circulated is limited by its boiling point at the given pressure, which for the open-tank system is 212 deg. In practice, it is necessary to keep somewhat below this, as the temperature is likely to vary somewhat, unless carefully watched. There will be no particular damage done, however, if the water does boil, provided the expansion tank is properly vented outboard; but it produces rather startling noises within the system and is likely to frighten the occupants of the building.

Hydrostatic pressure will, of course, vary on different floors; but the safe temperature is fixed by the pressure existing in the highest radiators, as this is where boiling will first take place. The temperature of the circulating water may be raised by increasing the pressure and thus raising the boiling point. There are various ways of doing this, one being to employ a closed expansion tank, the upper part of which is filled with compressed air at a given pressure, by means of an automatic pump. Should the temperature rise above the normal, the overflow of water into the tank will cause a certain amount of air to be forced out through a relief valve, and when it drops again, the air pressure will be brought up to the normal by the automatic compressor. In this arrangement the tank should be located in the basement and connected with the return main near the circulating pump.

In other cases, this result is secured by means of "generators," "intensifiers," etc., some forms of which are shown in Figs. 4 to 7. In the first of these, A is a cast-iron cylinder with a chamber, B, connected with it by means of the tube, C, the lower end of which projects for about 1½ in. into a mercury seal, M. The expansion pipe from the heating system is connected at E, and that leading to the expansion tank at T.

When in operation, the entire space above the surface of the mercury to the expansion tank is filled with water. As the water in the heating system rises in temperature, it expands, thus forcing down the surface of the mercury in chamber A and raising it in tube C. This continues until a sufficient quantity has been forced out of A to uncover the end of C. This allows the water to pass upward through the mercury into B, and thence through T to the expansion tank. In the meantime, a sufficient pressure must be maintained on the surface of the seal to hold it on a level slightly below the bottom of the tube in order to provide an outlet for the water as it increases in volume. This pressure depends upon the height of the tube in which the column of mercury is maintained.

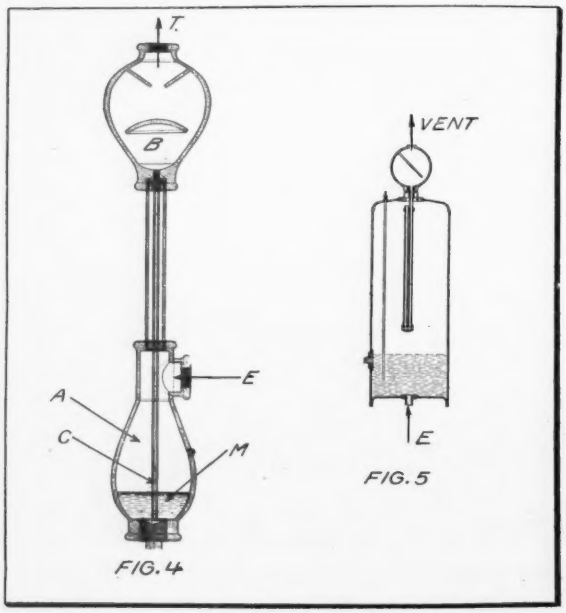
Ordinarily, a pressure of about 10 lb. is carried in the generator, which raises the boiling point of the water from 212 up to 240 deg.

In the arrangement shown in Fig. 5, a similar device is combined with the expansion tank, E being the connection from the heating system. The generator shown

*Continued from page 537, May 15 issue.

in Fig. 6 makes use of a pair of spring valves instead of a mercury seal. Here, as before, E indicates the connection with the heating system and T with the expansion tank.

When in operation it is filled with water, the pressure of which holds valve B to its seat. When the temperature rises to a point sufficient to create a pressure of 10 lb. per sq. in. in C, valve A opens and allows the water to pass into D and through T to the expansion tank.



FIGS. 4 AND 5. TYPES OF MERCURY SEAL GENERATORS

As the temperature drops, the water in the system contracts, thus forming a vacuum in C, which allows valve B to open and return a portion of the water above it to the system below.

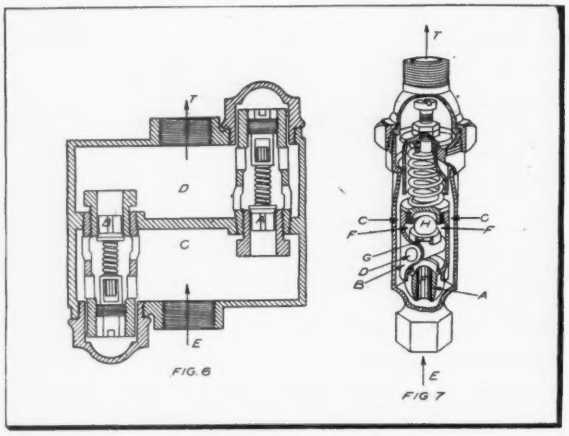


FIG. 6. SPRING VALVE GENERATOR

FIG. 7. BALL CHECK AND SPRING VALVE INTENSIFIER

The general principle of operation of the intensifier shown in Fig. 7 is practically the same as that just noted. The method in which it acts is briefly described as follows: E is the connection with the system and T with the expansion tank. A is a valve held in place by a coil spring and preventing the water from passing from E into the chamber C. H is a spherical valve which prevents the passage of water from chamber F through D into C. When the water within the system expands, due to a rise in temperature, the pressure causes valve A to lift, carrying with it valve-chamber B against the pressure of the spring. The excess of water will then pass into C, which leads to the expansion tank through T. When the temperature drops, A being closed at C, water will pass from C through D, lift the valve H, and flow into pipe E through F.

All four of these devices are connected into the expansion pipe at the point most convenient, and have the effect of raising the boiling point about 30 deg.

Heaters

While specially constructed heaters are sometimes employed for this purpose, the ordinary closed feed water heater is generally used, by simply reversing the connections. In the case of feed water heating, the steam is usually on the outside of the coil or tubes and the water on the inside; furthermore, the steam connections are much larger than those for water.

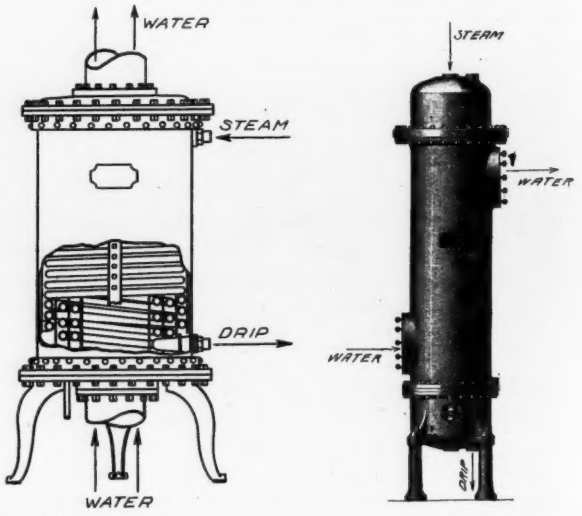


FIG. 8. NATIONAL FEED WATER HEATER, SHOWING CONNECTIONS USED IN HEATING SYSTEM

FIG. 9. GOUBERT FEED WATER HEATER AS USED IN HEATING SYSTEM

When used for heating purposes, a large volume of water is warmed through a comparatively low range of temperature, and the quantity of steam required is much smaller proportionally than in the case of feed water heating. The method of making the water, steam and drip connections with a National feed water heater, when used for this purpose, is shown in Fig. 8, and for a Goubert vertical heater in Fig. 9.

When heaters are especially designed for this purpose the arrangement is generally made the same as for feed water heating; that is, with the steam outside the tubes and the water inside, as the heat transfer is much more rapid with this arrangement. The methods shown in Figs. 8 and 9 are for the purpose of utilizing ready-made heaters without costly changes in size of outlets.

When the maximum temperature at which the water is to be circulated is somewhat below 212 deg., one or more exhaust heaters may be used, set either in series or in parallel, and if the supply of exhaust steam falls short of the requirements, live steam at a reduced pressure may be admitted to make up the deficiency. In this case, however, the oil should be thoroughly removed from the exhaust steam so that all of the condensation from the heater may be returned to the boilers. Care should also be taken to set the reducing valve in the live steam connection so low that no additional back pressure will be thrown upon the engines by this arrangement. A heater of this kind, is, if properly proportioned, a condenser, and if connected with an air pump, may be made to produce a low vacuum similar to that obtained in certain forms of vacuum heating systems. If it is desired to carry the temperature of the water much above 200 deg., or, say, to 230 deg. or more, as may be done with a pressure system, live steam must be employed, and also in a separate heater, so as not to raise the back pressure. In this case, the water is first passed through the exhaust heater and then the live steam heater to give it the desired final temperature.

The amount of tube or heating surface will depend upon the average temperature of the water passing through the heater, the steam pressure, and whether the steam is upon the outside or inside of the tubes. Table IV has been made up for the average conditions of practice, from data based on actual tests, and will be found useful in making computations of this kind.

TABLE IV. HEAT UNITS TRANSMITTED PER SQUARE FOOT OF TUBE SURFACE PER HOUR

Average temp. water passing through heater, Deg. F.	Steam inside the tubes			Steam outside the tubes		
	0 lb. (gage)	10 lb. (gage)	60 lb. (gage)	0 lb. (gage)	10 lb. (gage)	60 lb (gage)
160	5000	.....	.....	8000	.....	.....
180	3500	10,500	.....	5000	16,000	.....
200	.....	7,500	13,500	.....	10,500	40,000
220	.....	.....	27,500	.....	.....	35,000

The use of the table will be made clear by working 1 or 2 practical examples.

(1) A heating system requires 2,000,000 B.t.u. per hr. The water is to be delivered at a temperature of 195 deg. and returned at 165.

Exhaust steam at atmospheric pressure is to be used in a heater so designed that the water will be on the inside of the tubes and the steam on the outside. How many square feet of tube surface will be required in the heater?

Referring to Table IV, we find that for the above conditions (average temperature of water 180 deg.), 1 sq. ft. of tube surface will transmit 5000 B.t.u. per hr.; hence, $2{,}000{,}000 \div 5000 = 400$ sq. ft. will be required.

(2) Suppose, in the same plant, it is desired to raise the temperature of the water upon special occasions to a maximum of 235 deg. by passing it through a similar secondary heater, using live steam at 60 lb. pressure. How many square feet of tube surface will be required in the second heater?

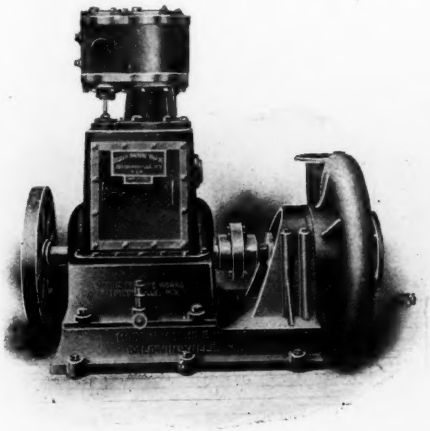


FIG. 10. ENGINE DRIVEN CENTRIFUGAL CIRCULATING PUMP

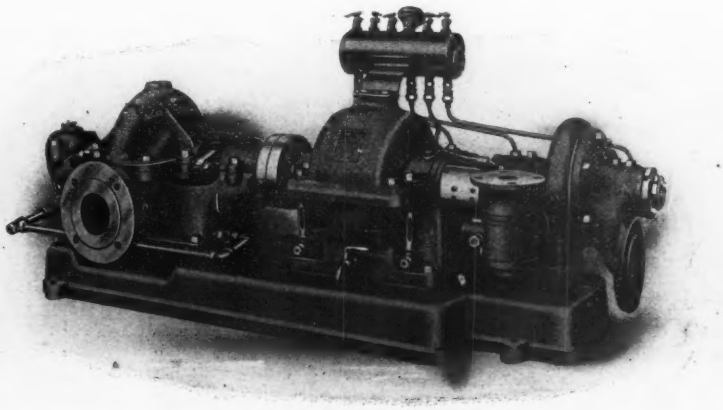


FIG. 11. TURBINE DRIVEN PUMPING OUTFIT

In this case, the initial water temperature will be 195 deg., the final 235, and the average 215.

Looking in the table we find that with an average water temperature of 220 deg. and steam at 60 lb. pressure, 1 sq. ft. of tube surface will give off 35,000 B.t.u. per hr., which conditions are near enough to the actual for practical purposes and on the side of safety.

If 2,000,000 B.t.u. are required to raise the temperature of the given volume of water from 165 to 195 deg. (30 deg. rise), then, for a rise of 40 deg. (from 195 to 235 deg.), it will require $2{,}000{,}000 \times 40/30 = 2{,}700{,}000$ B.t.u. approximately; therefore, $2{,}700{,}000 \div 35{,}000 = 77$ sq. ft. of tube surface are required in the high-pressure heater.

The great difference in the amount of heating surface required in the 2 cases, is due to the fact that for a given steam pressure, the heat transmission per degree difference in temperature between the steam and water, increases with the temperature of the water; also, that for a given water temperature, the rate of heat transmission per degree difference increases with the temperature of the steam. Therefore, for both higher water and steam temperatures, the rate of transmission per degree differ-

ence is increased in 2 ways. The reason for this is not clearly understood, and the increase in transmission, as affected by these conditions, does not seem to be uniform, but is true in a general way. The figures given in Table IV are approximately true for the conditions there stated.

In connecting up 2 or more exhaust heaters, they may be either in series or parallel, as most convenient; but when a supplementary live steam heater is used to raise the water to a higher temperature than can be obtained by the exhaust, it must be connected in series, so as to receive the water after it has passed through the exhaust steam heater. All heaters in a plant should be provided with cut-out valves and bypasses so that they may be used either together or independently, as conditions may require.

Pumps

Centrifugal or turbine pumps are commonly employed in this class of work, although piston or plunger pumps are used to some extent in large district heating plants where the water is forced through the mains under a considerable pressure. Centrifugal pumps are well adapted to office buildings and similar cases where

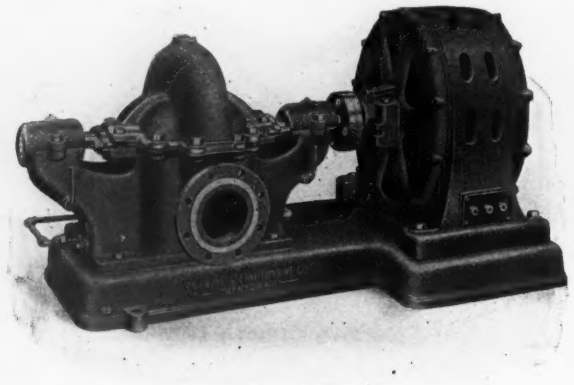


FIG. 12. MOTOR DRIVEN PUMPING UNIT

the water is circulated under a comparatively low head.

They are simple in construction, having no valves, require but little care, and are well adapted to either an engine, turbine or motor drive.

A pumping outfit employing a direct-connected steam engine is shown in Fig. 10. An engine drive is especially adapted to cases where it is desired to regulate the temperature of the building by varying the quantity of water circulated as well as its temperature. The speed of an engine is easily varied without any appreciable loss of efficiency, as the exhaust steam is turned into the heater and utilized. Special low-speed pumps are necessary with this arrangement, as they must run at the same speed as the engine. Although belted pumps may be used if desired, the direct-connected outfit is more compact, which is often an important matter where space is limited, as in office buildings and similar locations.

A steam turbine driven equipment is shown in Fig. 11, and a motor drive in Fig. 12. Both of these arrangements are compact and well adapted to this class of work. In this case the pumps run at a higher speed and must therefore be designed accordingly.

As previously stated, in the heating of buildings, the mains are so proportioned that the friction head does not usually exceed 60 ft., while 20 to 40 is more common. Under favorable conditions, an efficiency of 60 to 70 per cent is often obtained; for hot-water circulation it is more common to assume an efficiency of about 50 per cent for the average case.

TABLE V. (Low Speed).

Diameter of delivery, inches	Gallons, per minute	Diameter of impeller, inches	Horsepower per foot lift	Friction head in feet, and revolutions per minute							
				16	20	25	30	35	40	50	60
3	240	22	0.14	380	420	470	510	550	580	645	700
4	430	26	0.22	310	340	370	405	435	465	515	560
5	734	29	0.31	280	295	320	350	370	400	435	470
6	1050	32	0.45	240	265	290	320	340	360	395	435
7	1440	34	0.61	220	250	275	300	320	340	375	405
8	1880	36	0.79	210	235	260	280	300	320	355	390

TABLE VI. (Medium Speed).

Diameter of delivery, inches	Gallons per minute	Diameter of impeller, inches	Horsepower per foot lift	Friction head in feet, and revolutions per minute							
				12	16	20	25	30	35	40	50
3	240	13	0.14	565	640	710	780	850	910	970	1080
4	430	14	0.22	510	580	640	705	765	820	870	960
5	734	16	0.31	430	485	530	585	635	675	720	800
6	1050	18	0.45	385	400	480	530	570	610	650	715
7	1440	21	0.61	330	370	405	450	485	520	550	605
8	1880	24	0.79	285	325	355	390	420	450	480	530

TABLE VII. (High Speed).

Diameter of delivery, inches	Gallons per minute	Diameter of impeller, inches	Horsepower per foot lift	Friction head in feet, and revolutions per minute							
				10	12	16	20	25	30	35	40
3	240	9	0.14	745	810	920	1020	1130	1220	1320	1400
4	430	10	0.22	645	695	790	875	970	1050	1130	1195
5	734	11	0.31	570	615	690	765	840	910	970	1030
6	1050	12	0.45	530	570	650	710	780	845	905	960
7	1440	14	0.61	450	490	550	605	670	720	775	820
8	1880	16	0.79	395	425	480	525	580	630	675	715

The horsepower for driving a circulating pump is given by the formula,

$$\text{Hp.} = \frac{8.3\,F\,G}{33{,}000\,E}, \text{ in which}$$

F = friction head in feet pumped against,
G = gallons pumped per minute,
E = efficiency of pump.

Centrifugal pumps are made in many sizes, with varying proportions to meet the different requirements of capacity and head. The following tables give data for centrifugal pumps abridged from the catalog of The Lawrence Machine Co. Table V is for low-speed pumps, such as would be used with a direct-connected steam engine, while Tables VI and VII are medium and high-speed for turbines and motors.

The use of the tables is illustrated as follows: An engine-driven pump to deliver 430 gal. per min. against a friction head of 40 ft. would have, from Table V, a 4-in. discharge, a 26-in. impeller, would be run at 465 r.p.m. and require $0.22 \times 40 = 8.8$ hp. for operating it.

Feed-Water Treatment

SELECTION OF FEED WATER, INTERPRETATION OF FEED-WATER ANALYSES, EFFECTS PRODUCED BY VARIOUS IMPURITIES. BY EDWARD H. ROBIE

TIME has passed when an intelligent engineer blindly took water from the most convenient well, river or pond, as the case might be, and trusted to a merciful providence that the boilers would not be scaled up at the end of a week's run so badly that he could not get a turbine cleaner through the tubes. It has not been so many years since a chemical examination of water was a comparatively rare occurrence. It was pretty expensive and besides anything so scientific as that, was supposed to be only for the largest plants. Nowadays, however, we are exhorted on every hand to "send in a jug of water for free analysis," and if any engineer has the choice of 2 or more water supplies and is not using the best one, it is certainly his own fault.

Of course there are many cases where all available sources have been experimented with to see what the effect will be on the boilers, but the fact remains that in many cases an engineer is using a bad water when he might, with little extra expense for piping, get a much better supply. So the enterprising engineer is taking advantage of the liberality of the boiler compound and softening system people and finding out just what is what.

It happens all too often, however, that when the analysis is received, the man untrained in chemistry really knows but little more about it than he did before. Perhaps he sees that there is so much Cl, free CO_2, half-bound CO_2, SO_4, CaO, etc. Or perhaps it's $CaCO_3$, $CaSO_4$, $MgCl_2$, etc. Or it may be so much calcium sulphate, magnesium carbonate and calcium bicarbonate. Or again, so much carbonate of lime, sulphate of magnesia, and nitrate of soda. In addition there are 2 accepted methods of giving the results in each case, either by grains per gallon or parts per million. And our Canadian cousins have more trouble here, for a gallon in Canada is an entirely different thing from a gallon in the States, and often the analyst does not specify which he means. The Imperial gallon used in Canada is equal in weight to 10 lb. of water, while the American gallon weighs only 8⅓ lb. Is it any wonder that there is confusion?

In the first place let's get straightened out on what the chemical symbols mean. The following table will enable any one to read an ordinary water analysis.

Element	Symbol	Common Name
Calcium	Ca	Lime
Calcium oxide	CaO	Oxide of lime or quicklime
Magnesium	Mg	Magnesium or magnesia
Magnesium oxide	MgO	Oxide of magnesia
Iron	Fe	Iron
Aluminum	Al	Aluminum
Oxide of Iron	Fe_2O_3	Iron oxide
Oxide of Aluminum	Al_2O_3	Aluminum oxide or alumina
Silicon	Si	Silicon
Silicon Oxide	SiO_2	Silica
	SO_3	Sulphuric anhydrid, sulphite
	SO_4	Sulphate
Carbon dioxide	CO_2	Carbonic acid gas
	CO_3	Carbonate
Chlorine	Cl	Chloride
	NO_3	Nitrate
Sodium	Na	Soda
Potassium	K	Potash

Any combinations may also be read; e.g., $CaCO_3$ is calcium carbonate or carbonate of lime.

The mineral matter present in the water is probably usually present in what is known as the ionic state. That is, supposing we dissolve common salt, NaCl (sodium chloride) in water. The compound is supposed immediately to break up into sodium and chlorine ions. But when we evaporate down to dryness these ions combine again forming salt the same as we dissolved. Therefore, when we see a water analysis in what is known as the combined form, it represents an attempt to show what kind of scale would form if the water analyzed were evaporated to dryness, and this is really what the engineer wants to know, rather than just what is in the water as it stands. It is impossible to tell just what kind of scale will form and, therefore, any combined analysis is only partially right; but an excellent idea of the character of the water may be had all the same.

If the analysis is reported in parts per million it is easily changed into grains per U. S. gallon by multiplying by 0.058,35. That is, 17 parts per million is equal approximately to 1 grain per gallon.

In addition to the mineral matter in water, there is almost always a large amount of air dissolved in it and this is never reported because the amount is so changeable. It is, nevertheless, important and should be gotten rid of for 2 reasons. In the first place, it tends to promote corrosion of the boiler, and, in the second place, in plants running condensing, it may cut down the vacuum, as the air pumps are compelled to handle a larger volume than they would otherwise have to take care of. Carbonic acid gas or free carbon dioxide is also almost always present in water and is rarely reported. This will also promote corrosion and lower the vacuum if present in sufficient quantity. Both of these gases are driven off when the water is heated to the boiling point.

Now let us consider the mineral matter present. Silica is usually present to the amount of about 1 grain per gallon in ordinary waters. In itself it will usually cause no trouble unless present in 4 or 5 times this amount. But combined with other scale-forming matter, it forms a very hard, flinty scale, so that it is advisable to see that it is not present in excess of, say, 2 grains, or 3 at the outside.

Carbonate of lime or magnesia forms a rather light porous scale, and if there is not much sulphate present, will not usually be particularly difficult to remove from boiler tubes. If less than 5 grains per gallon is present, not much trouble may be expected, but if these substances are present up to 15 or 20 grains per gallon, there is a liability of foaming in the boiler, as well as

a heavy scale formation, which will necessitate frequent cleanings to prevent burnt tubes. Most of the trouble from carbonates in the water can be prevented by passing the water through a good form of open or direct contact heater provided with a filter for removing the precipitated matter.

Lime and magnesia sulphates make the most trouble from hard scale of anything ordinarily found in natural waters. Almost any amount from 2 or 3 grains up will cause scale to form in the boilers, the thickness depending upon several factors, among them being the amount of sulphates present, the evaporation from the boilers, the amount they are blown down, the design of the boilers, etc. A water containing over 10 grains per gallon of sulphates of lime or magnesia, or both, should be avoided, if possible, as it will be almost sure to cause trouble.

If the analysis shows over a grain or 2 of chloride of magnesia present, look out for corrosion. Also, if there is a large amount of common salt or chloride of soda present in proportion to the amount of carbonates and sulphates, there is liable to be corrosion. If the salt content is above 10 or 15 grains, look out!

The soda and potash salts are not scale-forming, but will cause foaming, if present in large quantities, unless the boiler is blown down very frequently. Over 15 to 20 grains of soda sulphate, chloride, or carbonate in a water is liable to cause foaming unless special precautions are taken. A water containing over a grain or 2 of carbonate of soda is called alkaline. Such waters are found in some of our western states.

Sometimes we also find the volatile and organic matter reported. There is almost always present 2 or 3 grains, which comes under this classification, and this amount ordinarily does no harm. Where organic substances are present in considerable amount, however, corrosion and foaming are apt to occur.

Although it is not possible for every plant to have a complete softening system, every engineer should be certain that he is getting the best water available. Some people have the idea that because 2 water supplies are close together they must be the same, but this is erroneous, particularly if the wells are of different depths. The water from a very deep well may be considerably different from that of a surface well, but it is more apt to be the same the year around. Surface water is apt to change with the seasons, and while it might cause trouble at one time of the year, would be a good water to use during the remaining months. These are all things that it is well to know all about, both to save the engineer work in boiler cleaning and to promote the boiler efficiency, as the large losses due to scale of even moderate thickness are well known.

At Meadi, near Cairo, Egypt, a sun power plant was recently erected by Frank Shuman and is stated to be giving an efficiency of 57 per cent, 14 per cent greater than was obtained from a similar plant 2 yr. ago. Heaters having 15,000 sq. ft. of surface are arranged to avoid conflicting shadows so that they cover about an acre, and deliver 50 hp. during a 10-hr. day. This success has led to the proposal for a plant for irrigation work in the Sudan, which will embody new features and give still greater efficiency.

International Engineering Congress

AMONG the general subjects to be treated before the International Engineering Congress, 1915, probably the one having the broadest interest is that of Materials of Engineering Construction, which enters into all phases of engineering activity.

The list of topics which will be treated in this section is as follows:

(1) Timber.

(2) Preservative Treatment of Timber.

(3) Substitutes for Timber in Engineering Construction.

(4) Brick in Engineering Structures.

(5) Clay Products in Engineering Structures.

(6) Probable and Presumptive Life of Concrete Structures made from Modern Cements.

(7) Aggregates for Concrete.

(8) Slag Cement.

(9) Waterproof Concrete.

(10) Cements Containing Additions of Finely Ground Foreign Material.

(11) Economics of the World's Supply of Iron.

(12) The Life of Iron and Steel Structures.

(13) The Employment of Special Steel in Engineering Construction.

(14) The Place of Copper in the Present Engineering Field, and the Economics of the World's Supply Thereof.

(15) Alloys and Their Use in Engineering Construction.

(16) Aluminum in Engineering Construction.

(17) The Influence of the Testing of Materials upon Advances in the Designing of Engineering Structures and Machines.

(18) Cement Testing.

(19) Testing of Metals.

(20) Testing Full-Sized Members.

(21) Proof Testing of Structures.

The papers to be presented from the United States have already been arranged for from the recognized leading authorities on the various topics. Arrangements for the papers from foreign authors are being rapidly concluded, and the aggregation of papers which will be presented will constitute a broad review of the field and be of the highest value.

Marked interest in the Congress from foreign countries continues, and there is every evidence that the attendance from abroad will be large. It is hoped that all engineers in this country who have not yet subscribed as members of the Congress will give the matter their immediate attention and favorable action.

Full information concerning the Congress, the price of subscription, and the arrangement for purchase of volumes of the proceedings, may be obtained by addressing the Committee of Management, as follows: International Engineering Congress, 1915, Foxcroft Building, San Francisco, Cal.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Practical Electrical Engineering

DIRECT-CURRENT SWITCHBOARD PRACTICE; LOCATION, CONSTRUCTION, TYPES, INSTRUMENTS, AUXILIARIES. BY NORMAN G. MEADE

MODERN direct-current switchboards represent an evolution from the pioneer days of electric lighting which has followed the progress of electrical development. They are as essential to the equipment of a power plant as any piece of machinery, as switchboards have to be depended upon for controlling and connecting various circuits, as well as the collection and distribution of the station's output.

Formerly the location of a switchboard was one of the last points to be considered when laying out a power plant; but it is now accepted as first in importance, for the successful operation depends largely upon the ease and rapidity with which different units can be cut out or in, or various combinations of units made.

No exact rule can be laid down for the style of board to be used; this depends entirely upon the service requirements. In general, for small plants with but

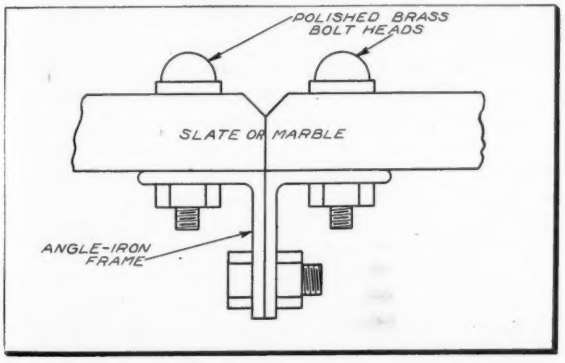


FIG. 1. METHOD OF MOUNTING AND JOINING PANELS

one generator, a single generator panel, with perhaps 1 or 2 feeder switches, is the usual equipment. For large plants with several generating units, the board may consist of several generator and feeder panels, and many times a totalizing panel, upon which are generally mounted an integrating wattmeter, an indicating wattmeter and, when required, a recording voltmeter. The entire load passes through this panel.

MECHANICAL CONSTRUCTION

MARBLE and slate are the universal materials used for modern switchboard panels; the panels are supported by angle-iron frames, the angle iron varying in dimensions from 2¼ by 1½ by ¼ in. to 3 by 2 by ¼ in., depending upon the size and the weight of the panels.

Figure 1 shows the manner of attaching the panels to the frame and also the method of connecting 2 frames together. The bolt heads on the front of the panels should be made of polished brass and the nuts placed on the back.

Large boards generally extend down to the floor, while small boards rest on legs, bringing the bottom of the panel some 24 to 30 in. above the floor. All switchboard frames should rest on a level strip, such as hard wood, channel iron or an I-beam; but as all frames for boards of 600 volts potential and under should be insulated from the ground, hard wood well filled with asphaltum is preferable.

In Fig. 2, a desirable method of permanently fastening the corners of frames is shown. A piece of ¼-in. sheet steel lagging is riveted on the reverse side, that

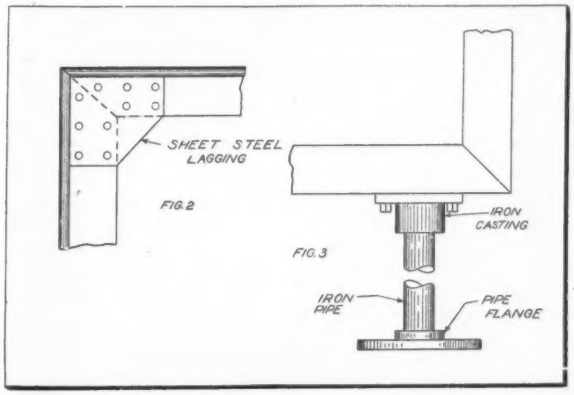


FIG. 2. BRACING OF ANGLE IRONS
FIG. 3. CONSTRUCTION OF SWITCHBOARD LEGS

is, the side enclosed by the angle, with ¼-in. soft steel rivets, which are headed over in countersunk holes on the face of the frame to allow for filing off surplus metal.

Substantial legs for a frame can be constructed as shown in Fig. 3, which consist of an iron casting, bolted to the frame into which is screwed a suitable length of iron pipe. An ordinary pipe flange serves for the foot.

It is well to brace frames from the wall by means of turn-buckles, so that the board can be plumbed when entirely erected. A space of at least 4 ft. should be allowed between a switchboard and the wall to permit ready inspection, cleaning and necessary changes.

Busbars and Connectors

Various panels of medium and large size switchboards, with the switching devices, are usually connected by transverse copper busbars built up of copper strips, ⅛, ¼ or ½ in. in thickness, as shown in Fig. 4; these strips vary in width, depending upon the required carrying capacity. This construction permits increasing the capacity of the bars by adding strips as required. It is common practice to allow a current density of about 1000 amp. per sq. in. cross-section of the copper.

It has been contended by some designers, that by the use of laminated busbars and large radiating surfaces, conductors can always be kept cool and the losses reduced. A density of 3000 amp. per sq. in. has been recommended by some engineers. The supposed gain is in keeping the temperature down so that it will not increase, due to the temperature coefficient for that conductor; but there are certain losses in energy which, as a rule, make it advisable to use additional copper.

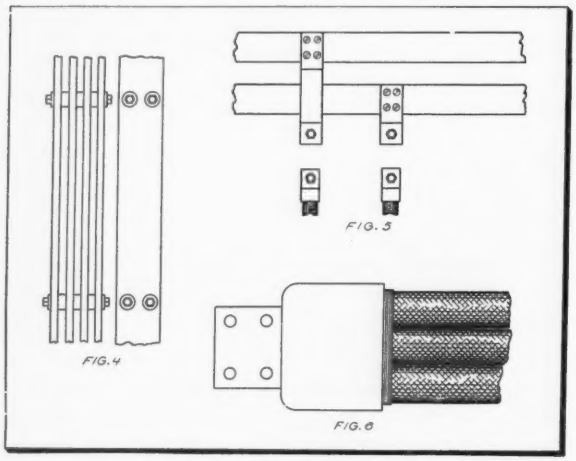


FIG. 4. BUSBAR CONSTRUCTION
FIG. 5. BRANCH CONNECTION TO BUSBARS
FIG. 6. CABLE LUGS

Switching apparatus and some of the instruments are connected to the busbars by bare copper strips, as shown in Fig. 5. The use of long studs for supporting the busbars is not advisable, as the weight of the latter is liable to throw the contacts on the surface of the board out of line. The copper strips are generally rigid enough fo support the bars.

All contact surfaces should have an area great enough so that the current density does not exceed 100 to 200 amp. per sq. in., depending upon whether they are clamped, bolted or soldered; steel bolts should always be used for connecting bars and lugs. Castings should always be made from new metal and should be rated at not more than 50 per cent of the carrying capacity of rolled or drawn copper. All minor connections should be proportioned 10 to 20 times the cross-section of rolled copper for equivalent carrying capacities.

Figure 6 shows the conventional form of lug or connector, for attaching cables to busbars. The cables are cup soldered and the depth of the holes should be from 2 to 3 times the cable diameter, and where it is necessary to fasten the cable to the lug with set screws, owing to frequent removal, the holes should have a depth of from 4 to 10 diameters.

(To be continued.)

Advantages of Y Over Delta Connections

THE question will arise at some time or other, in the mind of the man who is brought into contact with electrical machinery, when and why the windings of an alternator have been connected in Y or delta form.

We find that over 90 per cent of the alternating-current generators in use are of the Y connected type. This fact is attributed to the following reasons: (1) The Y connection allows of the bringing out of a lead from the neutral. This is of importance, for the reason that the neutral may be grounded thereby, or it may be used on a 4000-volt generator in connection with standard 2300-volt transformers connected to 3-phase 4-wire circuits. This system is the one generally employed in distribution work in large cities.

(2) Greater economy is obtained through the Y scheme of connection in construction of the machine, as but 58 per cent of the turns required by the delta connection are necessary to give the same voltage. This involves a large factor of cost in generators of high voltage and of a large number of turns per coil where the expense of internal insulation is great.

(3) With an ungrounded neutral Y connection, it is impossible for currents of triple frequency or multiples of triple frequency to circulate, due to the fact that at any instant the third harmonics existing in the 2 legs of a Y winding, which are in series between a pair of terminals, are equal and in opposite directions, and therefore neutralize one another. This, however, is not the case in a delta connected machine, as the currents therein circulate in the closed delta and the voltage which causes them to flow is short-circuited, therefore not appearing in the measured e.m.f. at the terminals. These circulating currents result in a large copper loss and also in a low efficiency.

(4) The e.m.f. wave of a Y connected machine approximates a true sine more nearly than does that of a delta connected alternator.

(5) The use of the grounded neutral reduces the potential strain on the insulation of the windings, resulting in a reduced thickness of this material.

The delta scheme has no advantages whatever which could in any way be compared with those of the Y. Its disadvantages are that in designing, particular attention must be paid to the percentage of pole face width to pole pitch, shape of the pole face and saturation of the magnetic circuit. It does not appear to have any advantages whatever, except as a convenience in design for certain voltages, and when so used, proper precautions must be exercised to avoid the circulating currents mentioned above.

We can readily see that, for convenience of operation, economy of construction and increased efficiency, the Y connected alternating-current generator is by far the superior.

Typical Electrical Power Plant Costs

By M. C. McNeil

THE cost of producing power is less today than ever before, notwithstanding the fact that the price of fuel and labor, two of the most important factors affecting power cost, have increased. The explanation of this rather remarkable truth may be summed up in one word—efficiency. This efficiency has been effected by the general progress in plant construction, operation and management, by the centralization of power, and by the betterment of the load factor, which is the ratio of the average load during any period, as 24 hr., to the average maximum load for one hour during that period.

With power plants, as with anything else that might be mentioned along manufacturing and industrial lines, the unit cost tends to vary inversely as the size of plant, increasing quite rapidly for small plants and decreasing less rapidly for large plants.

The installation cost of a plant affects the cost of power produced, in that the fixed charges (sometimes called overhead) are a certain percentage of the installation cost, usually around 10.5 per cent for turbine plants. This is made up of interest 5 per cent, taxes and insurance 2 per cent, and replacement fund 3.5 per cent, which is so proportioned that a certain percentage, say 3.5 per cent, if set aside annually and allowed to accumulate at, say, 4 per cent compound interest, will always be of sufficient amount to make any changes or replacement that may be demanded in the ordinary occurrence of events. The fixed charges, being a definite percentage of the initial plant cost, will vary as the initial cost varies.

The total cost of power, consisting of the operating cost and fixed charges, is a fluctuating quantity, depending upon 2 principal conditions; namely, size of plant and load-factor. Most of this variation is due to the operating expense, which constitutes about 80 per cent of the total power cost, and is made up of the following items mentioned in the order of their relative importance: fuel, labor, repairs and maintenance, oil, waste and supplies.

Fuel (coal being considered owing to its almost universal use) is by far the largest factor in operating cost, rarely being less than 50 per cent and sometimes as high as 80 per cent of the total. The widest fluctuation occurs in the fuel item also; for, in addition to the general factors of plant size and load-factor, there is the variation in the price of fuel in different parts of the country, as well as in the same locality, depending upon the quality and quantity used. The larger the plant the better the fuel economy, as large turbines are inherently more efficient than small ones, a fact that is also true for the boilers and all of the auxiliary apparatus.

As the load-factor falls off, the fuel cost increases, due to increased steam consumption per kilowatt-hour produced, since turbines operating at fractional loads are less efficient; and there is also a proportional increase in auxiliary power as the auxiliaries use nearly as much power at fractional as at full plant load. The general plant losses and inefficiencies are all proportionally greater, the smaller the plant and the lesser the load-factor, still further increasing the fuel item per unit of power produced.

The labor cost follows the same general trend as the fuel cost, although it is not so fluctuating, tending to be a fairly constant factor for any given plant. The load-factor does not affect the labor as much as it does the fuel item, as practically the same labor for a plant having a 75 per cent load-factor will be required by one having a 50 per cent load-factor, if the maximum load for the 2 plants is the same. However, this may not be the case, if the light load of the 50 per cent load-factor plant is of sufficient duration to make it practical to reduce the labor force during such times.

Large plants warrant the installation of labor saving devices, such as the mechanical handling of coal and ashes, such additions being an economic improvement when the extra fuel cost for operating and the additional fixed charges are less than the cost of labor dispensed with.

Oil, waste and supplies, and repairs and maintenance are rather indeterminate quantities, although experience has shown that they bear an approximate relation to labor and fixed charges, oil, waste and supplies being around 20 per cent of the labor cost, and repairs and maintenance about 15 per cent of the fixed charges.

Table I of Reference Tables gives some actual figures on installation and power costs; for central stations varying in size from 500 to 5000 kw., a greater variation obtaining within this range than for larger plants. Each of the plants is considered as normal rated at the size given in the table.

A point that may be open to criticism, is that the labor saving apparatus is not warranted for the smaller plants; as for the 500-kw. plant, the cost of labor dispensed with does not offset the cost of the extra fuel required for operating the labor saving machinery and the additional fixed charges for it, the total power cost probably being increased about 3 per cent. The 1000-kw. plant is about the dividing line, above which size the favor would lie with the labor saving machinery.

In central station service, the ideal condition of 100 per cent load-factor is never reached and seldom approached, the condition of 75 per cent load-factor being considered very good and only attained in some instances. However, the data given for these various load-factors, in Table II, Reference Tables, shows very nicely the point of varying power cost and indicates what cost it is possible to attain if the plant load-factor can be improved. The total cost of power, as well as the cost of each separate item, for the 5000-kw. plant is seen to be about 50 per cent of what it is for the 500-kw. plant. For a 50,000-kw. plant, this same proportion would not hold good, as each separate item, and consequently the total, decreases at a much slower rate above 5000 than above 500 kw. Observing the difference in successive pairs of items in Table I, it will be noted that they become smaller as the plant size increases, the tendency being for the item to become constant. Therefore, the total unit power cost for the 50,000-kw. plant would be about 75 per cent of that of the 5000-kw. plant, or about 0.32, 0.38 and 0.5 cents per kw.-hr., for load-factors of 100, 75 and 50 per cent respectively.

Owing to the fact that the turbine is not the only prime mover used in central stations, it may be of interest to note briefly some comparative figures on installation and power costs of other types of stations, such as the gas engine, the reciprocating steam engine and the combination of reciprocating steam engine and low-pressure turbine. The comparison will be fair only if like conditions are considered in each case as, for instance, the same fuel. Using coal as the fuel, the gas engine station is at once limited to a producer gas layout, which, however, conforms very well with the other plants in that the producers in the gas engine plant occupy the same relative position as the boilers do in the steam plants. For simplicity, only one size of plant (1000 kw. normal capacity) will be considered, the data and conditions for each plant being the same as cited in the turbine plant comparisons. The installation costs of the 1000-kw. plants are given in Table III, Reference Tables. This table may be criticised on the ground that the costs of the other plants as compared with the turbine are too high; but when the plant conditions adhered to are recalled, the data as given will be appreciated as being correct. The turbine plant as designed was capable of handling the maximum plant load with one unit shut down; similarly, the other plants must be capable of handling the maximum load with one of their units shut down. To do this, the gas engine plant will have to have a larger normal capacity than the reciprocating steam engine plant, which in turn will have to have a larger normal capacity than the turbine plant. This is true from the fact that the overload capacity of a turbine is about 50 per cent in excess of its normal rating, while the overload capacities of reciprocating steam engines and gas engines are about 20 and 10 per cent respectively, so that the actual normal plant capacity is the greatest for the gas engine plant and least for the turbine plant, though the installation cost per kilowatt is considered for the rating of 1000 kw. in each and every case. For other sized plants, the same proportional figures will be approximately correct, and so, referring to Table I and preceding paragraphs, the installation cost of any sized plant can be found.

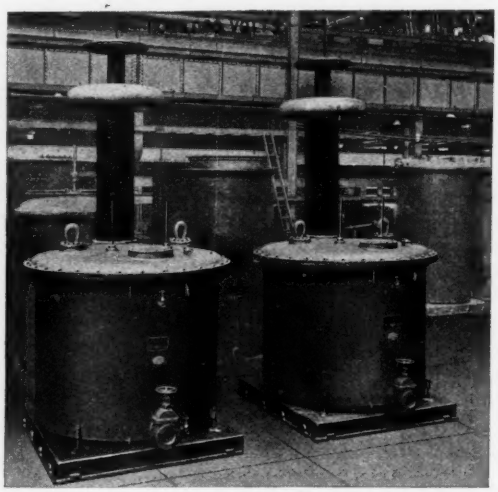
The cost of producing power for the different plants is given in Table IV, Reference Tables. For plants of other sizes than 1000-kw., as here considered, the same proportion of values will be approximately correct. The turbine economy, however, is proportionately better for larger units than is either the gas engine or reciprocating steam engine, though the reverse is true to some extent for smaller units. The fixed charges are different for the various plants, being 11.5 per cent for the gas engine, 11 per cent for the reciprocating steam engine, and 10.5 per cent (as before) for the turbine.—The Electric Journal.

To DRIVE small refrigerating machines by motors, a capacity of about 1.5 hp. per ton is required, and for larger machines 1.25 to 1 hp. For ice making, a compressor of 2 tons refrigeration capacity is required for each ton of ice per 24 hr. With apparatus such as the Audiffren-Singrun, 2.6 to 1.6 kw.-hr. of energy will be required to replace the use of 100 lb. of ice in refrigerators.

A Million Volts from Testing Transformers for Japan

THE Westinghouse Electric and Manufacturing Co. has just completed and shipped to Japan 2 testing transformers, having a normal rating of 360,000 volts continuously, and 500,000 volts for short periods. The accompanying cut illustrates these transformers, which were recently furnished the Inawashiro Hydro-Electric Power Co. of Japan, one to be installed in the generating station on the Nippashi River at the outlet of Lake Inawashiro, about 145 miles from Tokio; the other, in the receiving sub-station at Tokio, where they will be used for testing transmission lines and the apparatus in the stations.

Design features of interest in these transformers are: the arrangement of the windings to give distributed static fields; the use of condenser terminals to give distributed stresses from terminals to ground; and the



HIGH VOLTAGE TESTING TRANSFORMERS

terminal "hat" to distribute stresses from terminal tip to ground. The transformers are 19 ft. high from base to top of terminal and the tanks are 9 ft. high and 9 ft. diameter. One high-tension terminal of each transformer is grounded to the core and case, the other being brought out as shown in the illustration. By connecting the cases of the 2 transformers as shown, 1,000,000 volts can be developed between the 2 high-tension terminals.

BY THE PROVISIONS of a water power bill recently introduced in Congress, the Secretary of War is given power to regulate charges for electricity generated by a plant where the dam is constructed across a navigable stream, if the company does an interstate business. For unreasonable or discriminatory charges, the grant given by Congress for the erection of the dam may be forfeited, and this provision is made retroactive. Any method of limiting or controlling output is forbidden. States are left free to tax or lease power companies as they may choose, thus avoiding conflict between state and federal rights of control.

Steam Condensers for the Ice Plant

PREPARING DISTILLED WATER FOR THE ICE CANS. BY A. G. SOLOMON

TO get the water for filling the ice cans in a steam-driven compression ice plant, all the exhaust steam from the engines and pumps must be condensed and purified. First to be considered will be means for getting rid of the cylinder oil which has been used in lubrication of the steam cylinders. This is done by means of an oil separator on the exhaust line between the engines and the steam condenser.

There are many different kinds of separators, but they are all practically the same, and good results are obtained with any if they are handled right. The most common kind is made of a cast-iron shell with 2 or more baffle plates which deflect the course of the steam and cause the oil and condensation to fall into a chamber below the level of the exhaust line. The baffles and collecting chamber must be so arranged that the steam cannot pick up the oil again and pass it on to the condenser.

The drain from the collecting chamber is, as a rule, not connected to a trap, but the end of the pipe is left in plain view, so that it can be watched. The valve on the drain is left open just enough to allow all the oil and condensation to escape as fast as it collects.

The feed-water heater is also a place where some oil is caught before the exhaust goes to the steam condenser. If an open heater is used, care must be taken that the oil does not get into the boilers. Most, if not quite all, heaters have some device for catching the oil carried in the exhaust.

Now that the oil is nearly all eliminated, the steam is ready to be condensed in one of the several different types of condensers. These condensers are constructed in much the same way as are the ammonia condensers. They are of the 3 types: Atmospheric single pipe, double pipe and submerged; also, there are in use, the flask or dog house in many different forms and shapes, and also the inclosed surface condenser.

The common kind of atmospheric takes the exhaust in the top pipe and the distilled water is discharged at the bottom. The counter current effect of the cooling water is not considered a great advantage in the condensing of steam, for the distilled water must leave the condenser as hot as possible, and in that way save steam in the reboiling process. Just enough cooling water should be used to condense the steam, and no more. Have the pressure in the condenser a little above atmosphere, so that the foul gases will be thrown out through suitable openings left for that purpose. The pressure is controlled by the amount of cooling water used, and also by a relief or back-pressure valve located in the exhaust line between the heater and the condenser. Some of these condensers have 3 or 4 openings at different heights on the coils for the discharge of the water in the same manner as the ammonia condenser built in that way.

The double-pipe condenser is in use, but does not seem to be a general favorite. It is built on the counter-current plan mostly, but there are several arrangements. One style has the steam connected into every third pipe, and a distilled-water outlet for each set of 3 pipes. In this type especially, care must be taken that the coils do not get air bound and some of them become filled with water and by so doing, crowd the other coils so hard that they cannot condense the steam, and this causes blowing, and oil and dirt will be loosened and carried through to the reboiler, which cannot take care of a great amount all at once; this oil and dirt will lodge in some other part of the distilling system or might even go into the ice cans, with the resulting discolored ice which, in most cases, has to be thrown away.

Hard blowing of any steam condenser must be avoided. Dirty, scaly, cooling surface is a common cause, as is also low steam pressure, which allows the engine governor to ride so low that steam is admitted to the cylinder during the entire length of the stroke. This blowing has also been traced to faulty setting of the steam valves of engines and pumps and to badly leaking steam pistons which allow large quantities of steam at a high pressure to escape into the exhaust.

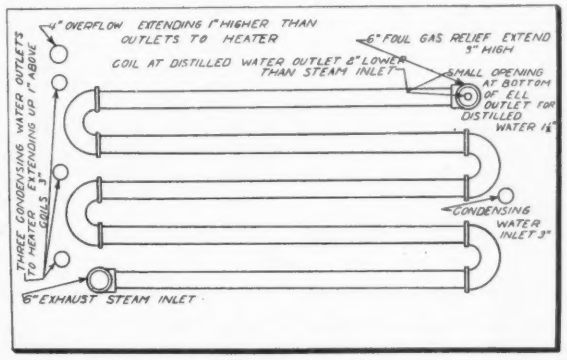

1" OVERFLOW EXTENDING 1" HIGHER THAN OUTLETS TO HEATER
6" FOUL GAS RELIEF EXTEND 3" HIGH
COIL AT DISTILLED WATER OUTLET 2" LOWER THAN STEAM INLET
SMALL OPENING AT BOTTOM OF ELL OUTLET FOR DISTILLED WATER 1½"
THREE CONDENSING WATER OUTLETS TO HEATER EXTENDING UP 1" ABOVE COILS 3"
CONDENSING WATER INLET 3"
6" EXHAUST STEAM INLET

FIG. 1. EXHAUST STEAM CONDENSER MADE UP OF 6-IN. PIPE LYING FLAT IN PAN

Find the real cause of any blowing that might occur and remedy it as soon as possible. Make some provision to turn the exhaust of the pumps into the atmosphere and this can be used when blowing occurs. A connection of this kind is also valuable to determine how the pumps are working.

The submerged condenser is made up of coils completely covered with water and is generally found very efficient if the scale does not form too heavy.

Cooling water for the submerged condenser is admitted at the bottom and overflows at the top. The exhaust steam enters the coils through a manifold header at the top of the coils and the distilled water is discharged through the same arrangement at the bottom.

By building the coils only 5 or 6 pipes high, they can be scraped and kept reasonably clean. As the feed water for the boilers is nearly always taken from the condensing water after it has passed over the steam condenser, there is always danger of letting a lot of scale and sediment go to the heater while cleaning the coils.

It is hard to prevent this entirely, but it can be avoided somewhat in the following way: Have 3 or 4 openings from the condenser pan or tank into the line that supplies the heater. In cleaning the coils, close the openings nearest to the place where the cleaning is being done, and by the time the water travels to the farthest opening, the sediment will have settled. These openings should have pipe or nipples in them, as the case might be, and take the water from near the top and the sediment will fall to the bottom, while the water on top will be clear. The heater must be cleaned regularly.

One type of submerged condenser which I have found to be easily kept clean and which gives no trouble, is made up of a coil of large-sized pipe, say 6-in., which is laid flatways in the condenser pan. The steam enters at one end and travels through the entire coil. At the opposite end, the distilled water is drawn off.

At the distilled water outlet of this type condenser, a full-sized ell is used, with the opening looking up, and into this a piece of 6-in. pipe is screwed, which

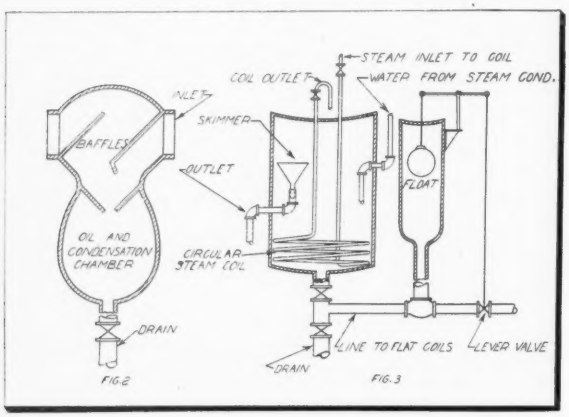


FIG. 2. OIL SEPARATOR IN EXHAUST LINE
FIG. 3. SKIMMER AND REBOILER

extends upward 3 or 4 ft. This acts as a foul-gas relief. The bottom of this ell is drilled and tapped for a 1¼ outlet line for the distilled water.

The coil is built with a very slight pitch toward the outlet. Use flanges in this construction, so that the coil can be easily taken out at the end of the season and the bottom part of the pipe thoroughly scaled. The coils are laid on 2 by 4 or 4 by 4 pieces of wood, and during the ice season, nearly all of the surface can be kept clean by using a long-handled scraper, bent to the circumference of the pipe; or, if a stiff wire brush is used daily, the scale will scarcely form at all. The top of the coils need only be submerged about an inch and in case of a small leak, the outside water pressure will not be great enough to allow dirty water to get into the condenser and mix with the distilled water; but clear, raw water can be allowed to mix with the incoming steam in a small quantity to help when not enough water is otherwise being made to fill the ice cans. This raw water will be so thoroughly atomized and heated that it will not show in the ice when frozen.

Another common type of steam condenser is the flask or dog house. These are cheap, easily cleaned, and give excellent service. The distilled water is discharged into the reboiler at a high temperature, and in some cases no reboiling at all is needed. They are made of heavy, galvanized iron and braced with angle irons on the inside. The outer surface is smooth, except for the rivet heads.

In most of this type the exhaust steam is admitted at one end and close to the bottom, then made to travel back and forth from one end to the other by means of baffles. As the steam is condensed, it drips down to the bottom and in so doing, is heated by the incoming steam.

Nearly sufficient reboiling is carried on by this arrangement right inside the condenser. The foul gases escape through an opening near the top. The condensing water flows in a thin sheet over the entire outside surface. They are easily kept clean by using flat scrapers or wire brushes or by the scale cracking off, owing to the breathing of the large flat surface.

All condensers are provided with a live steam connection to help make distilled water in case that the exhaust is not sufficient. Also a live steam connection is used to steam out the condensers to free them from any oil that may collect. After steaming out a condenser, it must be closely watched and the distilled water allowed to flow to the sewer till all particles of oil have been washed out.

As a general rule, the less a condenser is steamed out, the better the ice will be. Oil will not collect in noticeable quantities if care is taken with the lubricators and the separator is given proper attention. Use a good grade of mineral cylinder oil that will separate readily from the water.

Another form of condenser that is used to a small extent, is the inclosed surface condenser, built with circulating tubes in a shell similar to a return-tubular boiler. In the large tubed, upright type, the cleaning can be done with a turbine boiler tube cleaner by a man working from the top which is uncovered. In those of the horizontal style, with a great many tubes of small diameter, the cleaning is more difficult. This condenser has to be cut out of service and the head taken off to get at the tubes. A drill can be fastened to the end of a rod a little longer than the tubes, and then, by means of an air motor, the scale is drilled out. This is slow, hard work, but a good job is generally accomplished.

The cooling water mostly used on steam condensers is that which has already done work over the ammonia condenser. Extremely cold water is not necessary and is scarcely desirable.

In using the flask type condenser, be sure to leave sufficient atmospheric opening so that a vacuum is not created. Do not reduce the size of the opening provided by the makers by using bushings. Condensers have collapsed and become total loss by the vacuum which has been exerted on them in various ways. Do not cut out this type suddenly by closing the exhaust inlet valve quickly. For safety, it is best to shut off the cooling water just before the steam is shut off. There is scarcely any chance for raw water to get inside this condenser through a small leak, as it can in the double-pipe style through a split tube or poor gasket at the return bends.

(To be continued.)

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

"Dont's" for Diesel Engineers

By John Pierce

IN almost every standard set of books relating to the engineering profession one finds a chapter of "Don'ts," as well as a lot, generally, about the "how to do it"; however, there has been scarcely anything written, in any shape, as to the operation of the "Diesel Oil Engine," and it is my purpose now to write a short chapter of "Don'ts" as applied to this type of engine.

This chapter has been written from actual experience, the author having "done it" and found out either the advantages gained by so doing, or the resultant mistakes, and also by not "doing it" at other times, learned whereby he would have profited had he done so, and in time.

When the engine is set up by the "shop man" the operator probably being new on the job, as regards oil engines, will not know what to ask, consequently the erector will not be able to impart the knowledge that he otherwise would, did he but know what you want to find out; as soon as he has gone the new operator begins to wonder, and to discover many things which he should have inquired into.

1. Don't condemn, either to yourself, your employer, or your friends, the engine, for it is without doubt your own ignorance of it that is causing your hair to whiten, and not the fault of the engine or its builder.

2. Don't expect to start the engine, pump up a tank of oil, and then be able to go visiting. The Diesel engine needs your company as much as your old Corliss did, and being a strange engine in a strange place, possibly more so.

3. Don't get lazy, and put an entire day's run of water in the crankcase at one time, and feel that you have done your duty in this respect, for she wants a certain amount at *regular* intervals.

4. Don't put 1 gal. crank case oil in the case today, and 2 gal. tomorrow, but find out the right amount daily, and then use just that amount.

5. Don't fail to keep your fuel suction several inches from the bottom of your supply tank, in order to avoid getting water in oil.

6. Don't fail, when oil is low in your supply tank, to go down into it and see if there is any water there, and if there is, to pump it out, and as far as possible, to keep it out.

8. Don't fail to clean your screens, and at least every few days, when down, to clean the third screen.

9. Don't fail to draw off a little from the bottom of your feed tank occasionally, in order to remove any precipitated matter, or any water that may have been pumped up.

10. Don't get the idea that you can run the engine without water in the cooling jackets, and so neglect your circulating pump.

11. Don't try to run without a little water going over your needles.

12. Don't let your needle drains stop up in the lower part of the exhaust chamber, and blow out with the exhaust, but take out the plug, and run a small rod up into the drain and clean it out.

13. Don't turn the needle cooling water drip back into your cistern, or pond, but run it to the sewer.

14. Don't let your jacket water go over 135 deg. F. or you will form scale, which in time will make trouble with the cooling water.

15. Don't, if you are using heavy, lumpy oil, fail to put a screen around the mouth of your suction pipe.

16. Don't, if the engine slows down on a heavy load, get excited, and think she is no good, but examine the clearance between the needle valve levers and the disk they strike against, for perhaps they have too much clearance, as mere daylight between the disk and the lever is sufficient.

17. Don't fail to check "timing" of needles at the next shut-down, for the fuel noses may need setting ahead, or the rollers may have become badly worn.

18. Don't tighten fuel pump suction valve glands too tight, as all that seat them are the small springs, and these springs have a limit to their strength; it is better to let these valves leak slightly, than to prevent their seating by too much friction on their stems.

19. Don't forget that these springs get weak, but try to remember to change them when this occurs.

20. Don't fail to repack the delivery side of the fuel pump when it becomes necessary, for if one tries to tighten these glands too tight, especially if they are already scored, and leaking, the extra tightening only makes them score worse, and yet does not stop the leaking.

21. Don't, when these plungers are scored, fail to smooth them down with emery cloth, or a slight touch in the lathe.

22. Don't allow the little pins on the levers of the fuel pump to wear, and then neglect to adjust the seating of the suction valves, since the earlier or later seating of these valves has considerable to do with the power and the speed of the engine.

23. Don't fail to clean atomizer every 3 months. Perhaps one time they will not need it, and so the next time you will be inclined to "let her go" awhile longer;

but this may get you into trouble, and you should examine them at least, and be sure they are clean.

24. Don't fail, when shut down at the end of regular periods, to take out the needles and see if they are scored. If so, smooth them, and if they have been leaking, repack them. If they have not been leaking, just graphite them, and replace the needles.

25. Don't fail to take the diameter of the flywheel, and the diameter of the fuel needle cam, and work out the degrees per inch on the wheel and on the cam, and thus learn what part of an inch on the cam one must move the fuel-nose in order to advance the "time" 1 in. on the wheel, writing it down, so as quickly to set the nose ahead when "timing" the needle.

26. Don't fail to drain the water from the air receiver once a week.

27. Don't fail to charge your storage bottles once a week, for while you may not have used any of the air, valves leak sometimes, and though each time you examine the bottles you find them full, yet the next time, especially if you need the air, you are liable to find that one or more of the bottles has gone empty.

28. Don't let every salesman that comes along, tell you his oil is the best, or even as good, for your crank case, but stick to the prescribed oil as you would to a prescribed medicine.

29. Don't fail to apply the above to packing, as well as to oil.

30. Don't imagine that because the exhaust valve springs persist in breaking, the engine must be shut down at that instant, or that she is a poor engine on account of it. The writer has run 12 weeks with a broken spring. Just rig up a "jury" spring and go ahead.

31. Don't think you need never "grind in" your valves, and—

32. Don't think you need to grind them every day. An operator who watches his engine will quickly learn how to tell when his valves need grinding.

33. Don't neglect your compressor, for it needs you as well as your engine.

34. Don't think that because the most of your bearings are swimming in oil they need no attention.

35. Don't be afraid to go into, and examine the interior of your crank case. The oil therein will not hurt you.

36. Don't leave any more tools in the crank case than you have to, for then they will not be available when you need them, and besides, they might damage the gears.

37. Don't leave rags and waste on the deck to blow into the governor.

38. Don't fail to change the cloths on the intake of the compressor and on the admission valves when they become dirty, and don't run without these cloths, or in time you will regret it.

39. Don't fail to use an occasional drop of oil in the dashpot.

40. Don't fail to know that your fuel pump delivery checks are holding. The oil will blow out the fuel pump air vent if they get to leaking.

41. Don't fail to take the water head off your cylinder head at least once a year, and clean out any mud or scale therein.

42. Don't forget that the writer has done all of these things, and where you are warned not to do a thing he *has* done it, and where he tells you to do a thing, he knows, because he did not do it, and so has found out these things by having suffered the results that you will have if you persist in doing as he did.

43. Don't forget to keep her clean, treat her right, baby her a little, and above all, don't forget to remember "Don't No. 1" of this chapter, and your troubles will be but few, as compared to what mine were.

Hints on Maintaining Diesel Engines

IN a letter to the Power User, a correspondent gives the following points which have been found valuable in keeping Diesel engines from 300 to 500 hp. in service. These engines were of the 4-crank type and gave some difficulty from crank-shaft breakages when first installed. The engineer in charge decided that unless the valve setting on each cylinder gave the same compression and the same ignition pressure, unequal wear would probably take place in the crankshaft bearings, and that a little wear in this way would lead to the springing of the shaft, which coupled with the uneven turning moment, due to the unequal pressure, would result in severe stresses, which might cause breakage.

For this reason, the engines were constantly indicated, and the diagrams from the respective cylinders carefully compared for compression, ignition pressure, and work developed. Any differences showing up between cylinders were at once taken care of, so that the wear on the crankshaft bearings and on all reciprocating parts was reduced to a minimum and equalized.

In addition, the alinement of the crankshaft was checked week by week, and any error, even the slightest, was at once corrected, with a result that breakdowns became an unknown thing for a long period.

Some difficulty was also experienced from the blowing off of cylinder heads, because ignition occurred at wrong times and in wrong places. The oil from the crank chamber, and other oil used on the engine, was carefully filtered, and after thorough cleansing, this oil was used over again on all parts of the engine, including the air compressor. After one blow-out, the engineer decided that the trouble might lie in the use of filtered oil in the air compressor, and examination showed that it was almost impossible to avoid, in the filtered oil, traces of the crude oil used for fuel. After finding this out, the engineer gave strict orders that only new oil should be used for air compressor lubrication, and no further trouble was experienced from improper ignition, which indicated that this was the right course to follow. It must be remembered, that while the engineer decided that attention to the above points will give satisfaction where it is carefully followed, only an experienced and well qualified engineer is capable of carrying out such a program, and the detail of the work should not be left to cheap and inexperienced attendants.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Danger in Tight Fits

STEAM HAS a disagreeable habit of seeking escape whenever the joints of the surrounding walls are not closely fitted. The tendency to prevent its escape often results in greater actual losses than if a slight blow were permitted. Quite frequently, careless attendants take up on packing gland nuts until the friction of the packing on the rods produces a far greater mechanical loss than the energy represented by the slight blowing out of steam, which, although annoying at times, would at least not cause excessive work on the machine, thereby decreasing its efficiency and available power. A good engineer ought to be able to judge the amount of take-up on glands or packing, necessary to prevent properly loss of steam, water or air, without unduly binding them, and still prevent leaks.

Clearance, between balanced slide valves and their cover plates is frequently a matter requiring most careful judgment. In a plant under the writer's observation, a fatal accident recently occurred due to mistaken judgment of clearance space and the expansion of metals when hot. In repairing a cover plate for a valve, a very small clearance was allowed which seemed sufficient, especially when all the parts were cold. In starting up

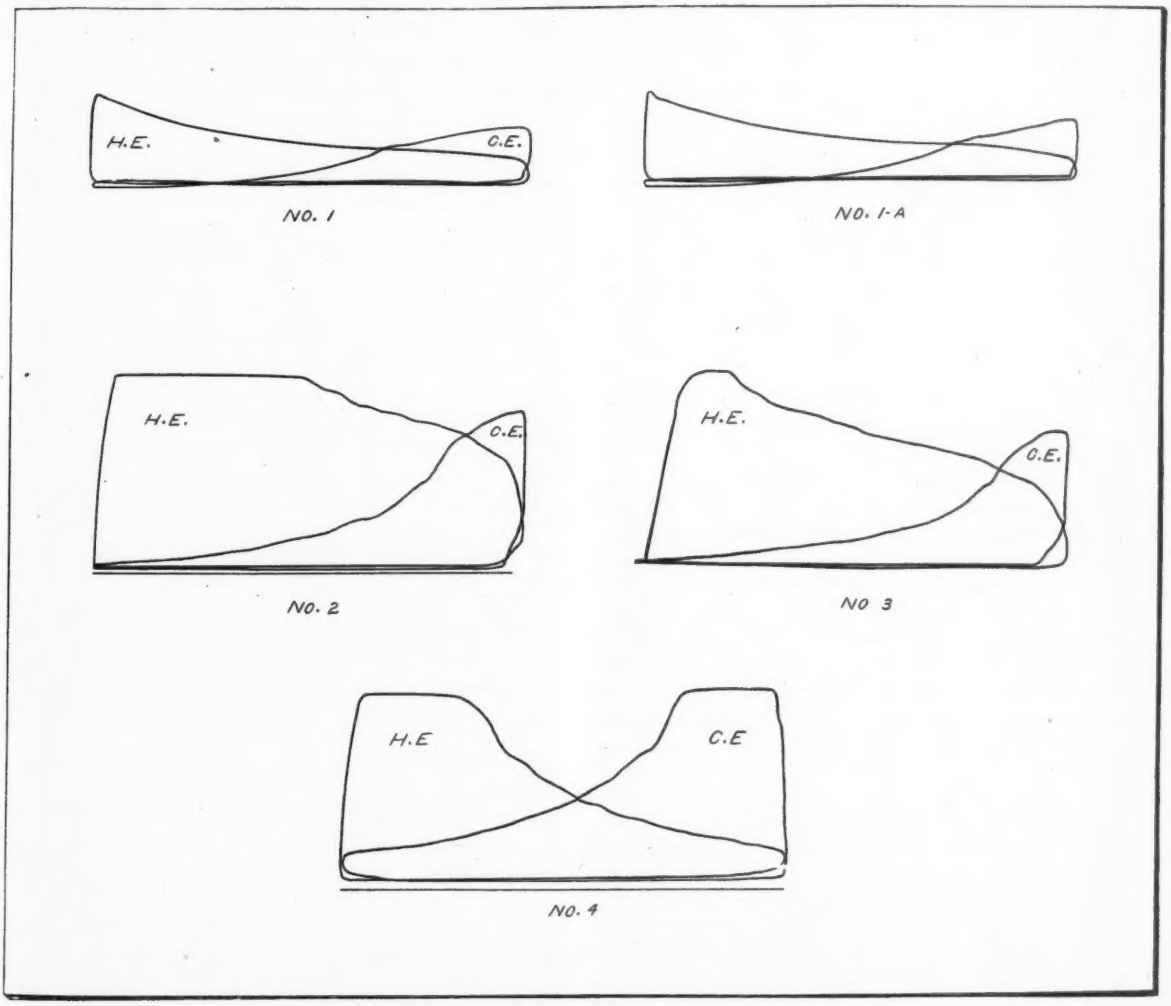


FIG. 1. SUCCESSIVE CARDS TAKEN DURING THE PROCESS OF SETTING THE VALVE

the engine, everything appeared to be working well and full pressure steam was turned on. The engine had barely attained its regular speed before a disastrous wreck occurred. The valve rod and eccentric strap were broken off sharply and thrown toward the cylinder, striking and fatally injuring the engineer, who was still at the throttle. Upon investigation, it was found that the valve had expanded sufficiently to grip the cover plate and, in locking, naturally caused the wreck of the eccentric and valve rod. As frequently occurs with an apparently troublesome machine, the engine was scrapped upon the arrival of the new engineer.

In a certain plant, a newly built steam-driven air compressor equipped with a Meyer cutoff valve, was recently installed. Before starting, the machine was carefully examined and everything found to be apparently O. K. From the very first run, a defect in the valve setting was detected by the exhaust, which indicated that the setting was mostly wrong at the shorter cutoffs and not noticeable at the longer positions. Presuming

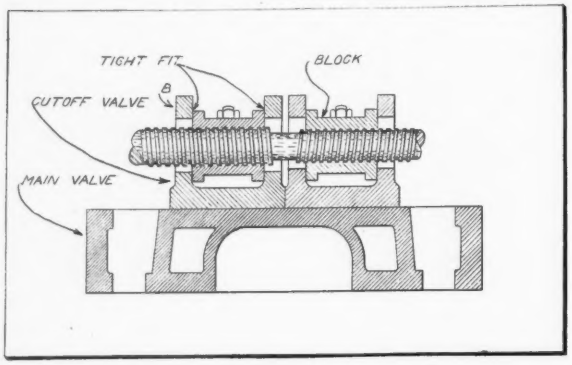


FIG. 2. RIDING CUTOFF VALVE WHICH GAVE TROUBLE

that this was the builder's method of setting, especially as his trammels jibed up exactly with the trammel marks, no attention was at first paid to the machine.

It was finally decided to indicate the engine and, irrespective of builder's setting, try to make adjustment for more even steam distribution for the 2 ends of the cylinders, at the shorter cutoffs. The accompanying cards were obtained. No. 1 was taken at a light load. The crank end has a distinct cutoff, but the head end appears to have no apparent cutoff whatever. Adjustment was made on the cutoff valve rod, giving the head end more lap. Another card, then taken, resulted so similar to the first that still further adjustment was made in the same direction, but with apparently the same result. Then the original setting was returned to and the main valve was adjusted for a greater lap on the head end. Card No. 2 was then taken and shows a clear cutoff on the head end, but the work was very unevenly distributed. Still further adjustment was made, with the result as shown by card No. 3, showing negative lead on head end; but even then the inequality of work by the 2 ends of the cylinder is very apparent. It was then decided to examine the valve itself and find the cause for such mysterious performances.

On raising the valve-chest cover, the trouble was at once apparent. In the construction of the valve, as illustrated by the sketch, the cutoff valve rod passes through a block which should have a sliding fit in the valve B. The valve was found completely raised off its seat, gravity, seemingly, having lost all control of it; but the explanation was apparent when not even the sharp raps of a hammer would dislodge the valve from the block. In this position, no amount of steam-pressure would affect the seating, as the valve was open to pressure on all sides.

Of course, the valve and block were removed and filed so as to allow for expansion and sufficient play when both had expanded their full amount due to the temperature of the live steam.

When the engine was first examined, the valve was resting on its seat and gave every indication of staying there, but then all parts were cold. An excessive amount of water in the cylinder raised the valve off its seat and, due to the small clearance between block and valve and the expansion under the heat of the steam, the valve remained in its raised position and ran that way for several weeks before being corrected. At the long cutoff positions, no discrepancy in valve setting was apparent, as the main valve did the cutting off. In the other positions, steam was admitted to the head end irrespective of what the cutoff was supposed to be. The first card taken after the corrected valve was replaced is No. 4 and clearly illustrates the return to normal working.

F. W. BUERSTATTE.

Method of Proving Addition

THE ARTICLE on "Practical Arithmetic," in the May 15 issue, attracted my attention and proves instructive.

Some time ago, I overheard an engineer saying to his friend: "Say, Joe, what do you think, the 'boss' tells me to go over my figures on this estimate of shafting required, and prove my additions. Did you ever hear the like of that? How am I to prove my additions?"

At this point, I "butted in" and stated: "In school, we were taught a way to prove division by multiplying the divisor and the quotient together. We were taught a way to prove multiplication by dividing the product by the multiplicand. The result should be the same figures as the multiplier—if your figuring has been executed correctly. We were taught a way to prove subtraction by adding the remainder to the subtrahend and the result should equal the minuend."

"But how shall we prove addition?" you ask. I have told some people, who have to add long columns of figures, the following:

Let (A) represent an example—

	42		
	671		
(A)	885	33	
	396	38	(B)
	784	24	
	968		
	3704	3704	

Commencing at the top right-hand figure (1), add downward the unit column, which amounts to 24.

Place the carrying figure (2) over the tens column, add downwards, placing the carrying figure (4) over

the hundreds column. Then add the hundreds column.

To prove it is correct, commence with (9) in the hundreds column and add upwards; this column amounts to 33. Put down 33 alongside of the example (or on a separate piece of paper). Now add the tens column upwards; the result is 38. Put down as in illustration (B). Now, add the unit column upward; the result is 24. Put down as in illustration (B). These figures, when added, prove the original addition of example (A). By first adding downward, and then, when proving, adding upward, you do not come in contact with the same combination of figures. In the proving, it will be observed the hundreds column really represents so many units. (In example (A) 3300 units.) Similarly, the tens column represents 380 units, and, of course, the final column represents 24 units. These units, when added, prove the original.

If they do not prove, it is easily detected by comparison, just what has been incorrectly done, and only requiring one column (we will say) to be gone over—your carrying figures and proof being before you.

WILLIAM A. TUCKER.

Steam Pump Repairs

I READ the article on steam pump repairs by Mr. Bliven, and it brought to my mind a pump job I was called to remedy some years ago, that worried the owners considerably. They erected a cotton compress in a southern city, to use water pressure instead of steam, and bought 2 large hydraulic, steam-driven, duplex pumps from a company that wished to enlarge its plant. They saw the pumps do satisfactory work before they bought them.

Satisfactory work meant that a cotton bale of standard weight must be compressed to a certain size in order to get the required number in a car, by reason of the railroad company charging full freight, regardless of the number of bales.

The owners had the pumps overhauled by their machinist, but failed to get the required pressure, and after several days' delay and expense of all the compress help, they sent for the writer, who was at that time superintendent of an iron works, 30 mi. distant.

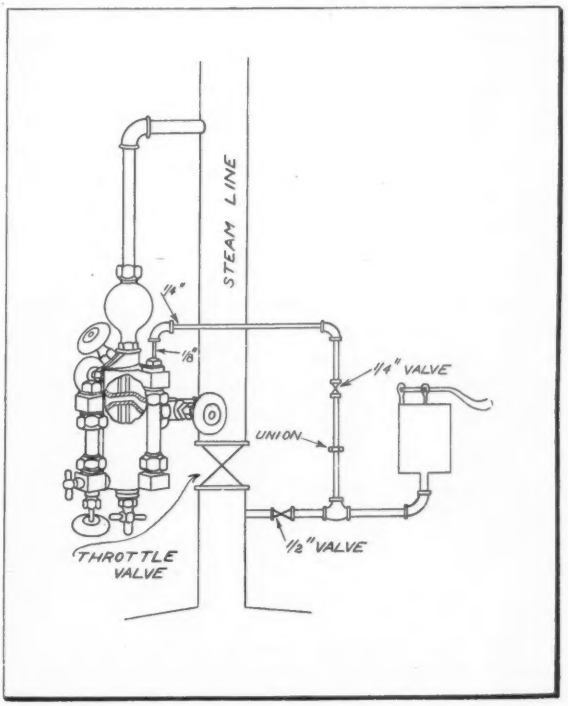
I examined the pumps thoroughly for steam leaks, but found none, and found the valves fairly well set; but on starting up, I found they lagged before the required pressure was reached. Feeling convinced that the space between the tappets on the valve stem in the steam chest and the lugs on the slide valves was too great, I slipped washers on 3 of the stems and reduced the space about ⅓, and the pumps promptly did the work. My opinion was, that when they trued up the valve stems, they lost 3 of the 4 extra washers.

OLD MACHINIST.

Filling the Lubricator

I WAS much interested in R. A. Cultra's method of making a large capacity cylinder lubricator from fittings in hand, but I have devised a method of filling the lubricator on my 18 by 36-in. Corliss which, to me, has advantages over the wall method large container.

I took out the nut over filling gage glass, tapped it for ⅛-in. gas pipe, put a short ⅛-in. nipple in, bushed ¼-in. elbow screwed on to the nipple, took a hand oil pump and piped to steam line as follows: viz., bottom of oil pump screwed into ½-in. elbow, nipple in the other end of the elbow, tee on nipple, another nipple in the run of tee, ½-in. valve, then another nipple screwed into the steam pipe. Now from the ½-in. tee next to the pump I bushed side-outlet to ¼ in., put on a ¼-in. valve, and connected this to ¼-in. elbow on top of lubricator. At any time during running time when the oil in the lubricator gets low, open the ¼-in. valve,



LUBRICATOR PIPING FOUND CONVENIENT FOR FILLING

give a few strokes of the pump, and you have the lubricator filled. When desired to pump oil directly into the cylinder, open the ½-in. valve, pump as if no connection to lubricator. The pump may be filled at any time and with little inconvenience.

L. W. GREENE.

A Little Joke

IN THE spring of 1912, I was engaged in installing 2 pumps and a feed water heater in a plant in Minnesota. While there, the boiler inspector for an insurance company called at the plant to look over the boilers and, as the plant would be run night and day, there was a young man engaged for night engineer who recently came from Michigan and had no license, but had corresponded with the State boiler inspector, who notified him that he would be in that town and would give him his examination. The insurance inspector says: "Of course, my firm objects to having boilers in charge of an unlicensed man; but the Minnesota inspection law is only a joke," and as I had just been through the joke

to the tune of a chief engineer's license, I thought perhaps the readers of Practical Engineer would like to know what kind of a joke it was.

I had had a first class license for some time and, wanting to increase it to the best grade issued in the State of Minnesota, I hied myself to the inspector's office and told Mr. Inspector what I was after. He laughed and began cracking jokes something like this:

What is air? What is water? What is the pressure of pure water, temperature 62 deg. F.? At what temperature does water begin to evaporate? Can water be compressed? Are superheaters extensively used? How much water can be evaporated with one pound of coal? What causes draft? What should be the tensile strength of good boiler plate? Is a boiler stronger when generating steam or when cold? Define the term of elastic limit. How strong are riveted joints in modern boilers compared to the strength of the boiler plates? Does riveting alone make a tight joint? How do we find the strain on each rivet in the girth seam? How would you find the number of 1-in. braces required in a certain boiler? How should large pipes be attached to boilers?

How do we find the bursting pressure of a horizontal-tubular boiler? How do we find the safe working pressure of a horizontal-tubular boiler? What is one boiler horsepower? How many times as much heating surface as grate surface will the average boiler have? Define heating surface. What is a water-tube boiler? Give a brief description of one make of a water-tube boiler. How does a steam gage work? What kind of pressure does a steam gage indicate?

What is the most important valve on any type of boiler? Give a rule to find the approximate size of safety valve for a given boiler. Give rule for finding the weight necessary to put on a safety valve at the given distance from the fulcrum so that the valve will blow at a given pressure. Begin at the boiler feed pump and name every fitting in order to the feed-water inlet to boiler.

Name the different classes of steam engines. What is the nature of the strain on the piston rod? Can the point of cutoff be changed in a slide valve engine? If so, how? What is the angular advance of the eccentric? Explain fully valve setting of the Corliss engine.

Draw indicator diagram of a perfectly set valve, cutoff one-third. Draw indicator diagram showing leaky piston. Explain the workings of an injector. Is there any limit to how high a pump will lift water? Give rule for finding the capacity of pumps. What is the difference between a piston and a plunger pump? The size of the driving pulley being known, how do we find size of the driven for any certain speed? What is a volt? What is an ampere? What is an electric horsepower? Describe a dynamo. Does a shunt machine maintain a constant pressure at all loads? What causes sparking at the brushes? Define the term phase. Describe a transformer.

After Mr. Boiler Inspector had passed jokes such as the foregoing for a little over 4 hr., he put on a nice smile and said: "I think I can give you your license."

Now if any of the eastern states' inspection laws call this law a joke, I think I'll stay in Minnesota, because after going through with this in 2 doses, I can't see any of the joke.

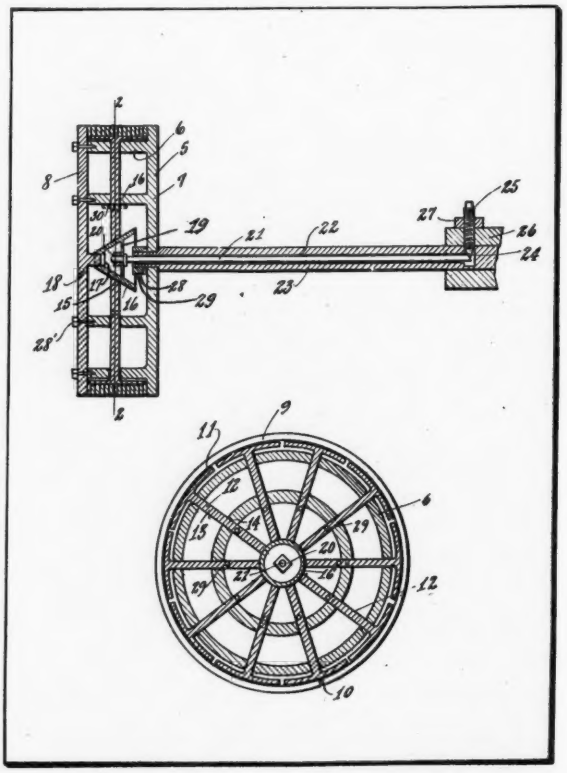
Now, a word as to the grades of Minnesota and eastern states' licenses.

Minnesota chief corresponds to New York City first class; Minnesota first class, to New York City second class; Minnesota second class, to New York City third class. Then there are limits as to horsepower and plants, also specials limited to some particular kind of machine, such as pile driver, steam shovel, steam drilling machines, and so on, innumerably.

F. M. J.

Piston Packing Adjuster

ACCOMPANYING is cut of a piston packing adjuster for which I have applied for a patent. I would like the



CROSS SECTIONS OF PISTON PACKING ADJUSTER

opinion of Practical Engineer readers as to what they think about the scheme. M. B. KRAMER.

UNITED STATES CIVIL SERVICE COMMISSION announces an open competitive examination for aid in the Coast and Geodetic Survey, on June 17 and 18, 1914, to fill vacancies in the positions of aid and deck officer in the Coast and Geodetic Survey. Applicants must have reached their 18th but not their 25th birthday. No one will be permitted to take the mental examination who has any physical defect, or who is color-blind. In applying for this examination, ask for Form 1312, using the title, Aid, Coast and Geodetic Survey (Male).

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Engine Requires too Much Oil

I AM in charge of a 24 by 28-in. double eccentric Corliss engine, running 78 r.p.m., steam at 100 lb. gage, which uses 7 or 8 qt. of oil in 10 hr. If I use less oil than this, the valves groan for more. Kindly inform me what should be done to remedy the cause of using so much oil. This engine has no separator, and is working quite hard. The cutoff is 50 per cent. J. S. H.

A. The question of cylinder lubrication is one which cannot be treated with much success away from the job, as there are so many conditions that affect it either singly or in any combination of them that it is difficult to prescribe the proper remedy.

We will, however, enumerate the probable causes of your trouble and offer some suggestions, which, we feel, will be of assistance to you in overcoming the difficulty.

It not infrequently happens that there is some obscure spot on a valve of a Corliss engine, where it is impossible to lubricate properly, owing to local conditions. Corliss valves should be provided with oil grooves where they bear at the ends. These grooves should be about 3/16 to ¼ in. wide, and at least about half as deep, nicely chipped and filed out, and laid out in such a manner that the ends of them are open to the steam space, thus permitting lubrication to reach every spot.

The ends of the valves should be treated in like manner, the grooves running radially, so that in rotating the grooves will distribute the oil-laden steam properly.

The quality of the oil has much to do with a difficulty, if it is a problem that simmers right down to the oil itself, having eliminated all of the possible causes which will be enumerated later.

Here is another problem which has not been given the consideration that it deserves. It is but natural that the reciprocating parts of an engine should wear sharp at the edges. This is especially true of the lower part of the piston and the steam packing rings, no matter what the type or design.

The valves and ports wear very sharp frequently. When this occurs, it is but natural that these sharp edges act as a scraper, and scrape the lubrication off the walls of the cylinder and chest, to such an extent that little remains.

The remedy for this is to take a smooth file, or a fine mill file, and "break" all the edges of the valves, piston rings, bull ring and follower, or other parts as used, at about an angle of 45 deg. On the working edges of the valves, care must be taken not to file off enough to affect the steam distribution, but just enough to present a beveled edge as the valve rotates across the seat, thus preventing the valve from scraping the oil from the seat.

On the piston you can be more liberal, especially on those parts which slide on the bottom of the cylinder, and can chamfer off enough to present a bevel edge 1/16 in. wide or more if you wish.

Considerable attention can also be given to the method of introducing the oil into the steam pipe and there vaporizing it so that it will thoroughly impregnate the steam. If this is done, then as soon as the steam strikes any part of the interior walls, either directly or through the medium of the oil grooves, etc., a film of oil will adhere to these parts.

In the early days of the sight-feed lubricator (and the practice prevails to a certain extent today), the lubricator was attached to the steam pipe by means of the union valve connection, which is a part of every instrument. This connection rarely extended beyond the inner surface of the steam pipe, and the oil as discharged trickled down the side of the pipe, instead of vaporizing, as it should, under more favorable conditions.

If a lubricator were to be attached to either the front or the back of the steam pipe of a Corliss engine in this manner, practically all of the oil would pass to the end of the cylinder over which the lubricator was located, and thus leave the valves at the opposite end with less.

If, however, the oil is fed fast enough to prevent groaning of the valves on the "dry end" of the cylinder, then the other end is receiving an excessive amount.

With any means of feeding the oil, best results are obtained by extending the feed pipe to about the center of the steam pipe, so that the drops of oil in falling are caught up by the steam in passing and thoroughly vaporized.

While good results are sometimes obtained by introducing the oil immediately above the throttle valve, or into the valve itself, yet as a general thing it is better to have it enter about a foot or more above the valve, as the tendency is towards better vaporization.

You say that the engine has no steam separator and that cutoff occurs at about 50 per cent of the stroke. We strongly advise that you install a steam separator of ample capacity as near the throttle valve as possible and have it well drained. Get a receiver-separator of a cubical contents about equal to the capacity of the cylinder, constructed in such a manner that it will separate the entrained water from the steam, and keep it separated.

Install a good, reliable steam trap to take care of the greatest possible amount of water, and one that is not liable to get out of order.

It is a well-known fact that water introduced with the steam not only washes off the surface of the ports and cylinders, but reduces the cylinder temperature to a considerable extent, which is detrimental to economical results, as it increases the steam consumption a great deal, which all reverts back to the coal pile, and this is money. Superheated steam is used principally to reduce the loss from saturated steam, or, properly speaking, wet steam.

Then, to go back a little farther for a probable cause for your difficulty—in fact, outside of the engine entirely: The boiler plays an important part on cylinder lubrication, or perhaps it is better to say, the lack of it. Certain impurities in the water float on the surface of the water in the boiler, and if the construction of the boiler, or the conditions of service are such as to induce foaming or priming to any extent, these gritty particles are carried over to the engine with the steam, where they lodge on the interior walls, and especially at the ends of the valves, where it is possible they may clog up the oil grooves entirely, and make a bad matter worse.

This process increases friction, which, in turn, increases the steam consumption, and this, in turn, further aggravates the original trouble in the boiler, especially if the boiler capacity is limited.

These boiler troubles, if they exist, may also be caused by a part of the excessive oil finding its way back to the boiler, either by the way of the open heater, or through the heating system. This may not be the case in the present instance, but we offer it as a possible remedy in an effort to solve the problem, either wholly or partially.

The fact that you are using 7 to 8 qt. of cylinder oil in 10 hr., when one would be indeed more than enough ordinarily, leads us to believe that there is some good reason for it. GEO. H. WALLACE.

Answers to Massachussetts Examination Questions

THE FOLLOWING are answers to examination questions on page 368, March 15 issue.

1. If water was coming back into the cylinder from the exhaust pipe and only one engine in the plant, I should look to see whether the drip on the exhaust pipe was clear, if the pipe rose above the cylinder. Also examine the drip on the heater to see whether that was clear.

Perhaps the coil in a heater has developed a leak, letting water come into the cylinder. In this case, the water line in the boiler would lower, making a higher pump speed necessary, which would naturally cause one to suspect a leaking heater. To prove the case, bypass the water around the heater. If the water ceases, then the heater is leaking.

Often, especially in cold weather, if the exhaust line is exposed and not properly covered, condensation may find its way into the cylinder, when the drip is not clear and of sufficient size. When more than one engine is in the plant, each should be provided with a gate valve under the cylinder in the exhaust line to prevent water backing up.

2. The proper way to cause earlier cutoff in a riding cutoff regulated by a throttling governor, is to advance the riding valve or cutoff valve eccentric on the shaft. Whether to move it with or against the direction of rotation will depend on whether a direct or indirect valve motion is used.

Place the crosshead at the dead center and carefully measure off a distance on the guides equal to ⅜ of the stroke. Then turn the engine in the direction of rotation until the edge of the crosshead comes up to the mark on the guide. Loosen the set screw in the cutoff eccentric and with the steam chest cover removed, turn this eccentric until the edge of the valve closes the steam port. Turn engine to same fraction of stroke from other end and see whether the cutoff is the same; if not, equalize by slight change of valve on stem or length of stem.

3 & 4. Engines found in third class plants, as a rule developing 50 hp. and less, usually have throttling governors to regulate the speed.

In some constructions, it is possible to loosen the lock nut and move the valve and stem into a higher or lower position in relation to the ports in the valve body, thus securing a larger passage throughout the governor valve. This will allow of a higher initial pressure in the steam chest without raising the boiler pressure. Whether this will enable the engine to run up to normal speed will depend upon conditions and cannot be determined without an examination of the machine.

Another way would be to reduce the steam lap, or turn the eccentric back, causing a later cutoff and higher mean effective pressure in the cylinder, and thus developing greater power.

If the engine was some distance from the boilers and the pipe contained several or small turns, the placing of receiver separator at the cylinder would tend to enable a higher initial pressure to be utilized. Another good point would be to line up the shafting carefully and reduce the friction load.

5. Whether it would be best to obtain a new packing ring for the valve from the maker, or to make one locally, would depend on location. Generally it would be desirable to make the ring locally. After removing the bonnet from steam chest and disconnecting valve stem from valve gear, remove the valve. Carefully caliper the valve chamber and also the diameter and width of the groove in the valve. Have wire gage made to these dimensions, and new ring turned to fit. With a thin metal shim between valve and ring gently slip the ring over the valve end and spring it into the groove.

6. If the ring was large, saw the ring across diagonally and cut out enough of solid metal to enable the ring to be sprung snugly into the groove.

7. Practically as for the whole ring, care being taken to dowel the ring so it could not turn all the way round in the groove and it would thus have the heavy side down and joint on top.

8. The general effect of oil is the same in all boilers. The grease floats on the water surface and collects other impurities and in time settles on some heating surface, continuing to gather scale, and the heat bakes it into

a hard mass. This is so slow in transmitting heat that the plates are overheated and a bag results, or the tubes and seams develop leaks, often to a dangerous condition. The boiler should be thoroughly cleaned and precautions taken to prevent more grease entering.

9. Suspend a straight edge over the length of the boiler with one end resting on the shell, level the straight edge, then lower the back end of the boiler until the desired pitch is obtained, being measured from the bottom of the straight edge to the shell, as shown.

It is customary to give the boiler a pitch of 1 in. in 18 ft. The writer prefers to make it 1 in. in 10 ft., to allow for the settling of the front end, which will eventually occur, due to repairs to furnace and side walls. If the boiler is 18 ft. long and the pitch 1 in. in 10 ft., the distance from straight edge to shell at rear should be 1.8 in.

10. Assuming the principal feature to mean, what should receive special attention,—that would mean that the front wall over the fire doors should be kept in best of condition and so completely covered and thus protect the front girth seam and dry sheet from burning.

11. Extending inward from the outer edge of the sheet to the rivets at the girth seams.

12. When this condition is found, it should be removed. If turning the engine from one dead center to the other, the striking points laid off on the guides prove the piston does not strike the head, then engine could be operated until repairs could be made.

13. If the boxes were originally babbited, rebabbiting will restore conditions; if brass boxes, a new set will overcome the difficulty. Perhaps the boxes can be planed or filed along the edges where they come together or are "brass bound," and with the introduction of shims further service gotten out of them.

14. In the B. & W. boiler with inclined headers of wrought steel, the handhole plates are secured to the outside of the header by an inside dog and outside nut, without packing, making a metal to metal joint. In the vertical header type, the handhole plates are fitted to the inside of the seat on the headers and are provided with thin gaskets.

15. With a leaky check valve, the water would have a tendency to leave the boiler and rise in the system until of such a height as to balance the pressure in the boiler. It would be accompanied by water hammer and, in some cases, result in an unsteady water level.

The radiators would not be hot, as when properly drained, and difficulty would be experienced in maintaining desired temperatures.

16. Yes, but the operation is not satisfactory, and if a power plant, the hot water resting on the pump valves makes it somewhat difficult to start the pump.

RECEIVER.

Answers to Electrical Problems

ON PAGE 544, of the May 15 issue, in answer to the questions on the previous page, No. 3, although it is a correct answer to the question intended to be asked, is not the answer to the actual question.

The question as asked is this: "In a 2-phase system, what is the voltage difference between the 2 phases?"

As a matter of fact, there is no voltage difference between 2 phases in quadrature unless interconnected at some point, and the difference of potential between any wires will depend on the point of interconnection. In fact, if they are not interconnected, the 2 wires of different phases may be used as the 2 legs of a third system (for instance, a direct-current circuit), making what is sometimes called a "phantom circuit." In this instance, the voltage between the phases will be the voltage of the direct-current system.

In the special case of a 3-wire, 2-phase system, the phases are interconnected at one of their terminals; therefore, the voltage between the phases is zero at one of their terminals, and the phase voltage multiplied by the square root of 2, or 1.41, at the other terminals or outside legs of the circuit, as given in the answer.

Answer No. 6 is also open to criticism. The last paragraph states that the ratio of the average to the effective voltage is the power factor. The writer of this understands the power factor and uses it correctly in a preceding answer. He evidently did not intend to say this at all. What he meant to say is, that the power factor is the percentage ratio of actual watts to the apparent watts. The ratio of the effective to the maximum value of either the potential or the current is the square root of the mean square as correctly stated earlier. The reason for criticising the rest of the answer is that the question is so blind. What the questioner means by "magnetic type," is hard to say. Except for such freaks as "hot wire" instruments and electrostatic voltmeters, all standard instruments depend on magnetism in some form as the deflecting force at the indicating needle.

The term "magnetic type" might be understood to be those having some form of a permanent magnet field; or, more specifically, the D'Arsonval principle as used in the Weston direct-current instruments. The answer, then, is that they will not work at all on alternating currents, with a single exception given in a moment.

What he means by a direct-current "wave," should be explained when answering. An electric impulse in one direction sent through a d.c. instrument, will cause an indication depending on the duration of the impulse and the inertia of the instrument.

At one extreme, we have the ballistic galvanometer which receives its entire impulse before any perceptible deflection takes place, the total deflection is then proportionate to the quantity of electricity. At the other extreme, is the Oscillograph, which shows the quantity and rate of passage or voltage and current form at all times during the existence of the phenomenon.

I. W. B.

IN A PAPER PUBLISHED by the Geological Survey, Karl Gilbert discusses the composition of the interior of the earth, and gives as his interesting deductions, first, that the material in the interior is rigid; second, that it is very dense, approximately 5.6 times as heavy as water, or twice as heavy as solid granite, and that it exists at an enormous temperature. As to the density and rigidity, the researches of scientists leave no doubt; but as to the question of temperature, it is a matter of opinion, as are all other statements in regard to the condition of the interior of the earth.

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The Combustion Chamber

Widely differing results customarily obtained from boilers of the same rating, but varying construction, are much too frequently laid to the general design of the equipment. Some constructions are doubtless better than others; but this alone cannot explain the wide discrepancy that is so often found between boilers of different manufacture, nor does it explain why, of 2 equally careful firemen, one may frequently be able to husband his coal to a greater extent than the other, and at the same time generate the same steam. The proportions of the combustion chamber may be, in large part, the cause of the difficulty, particularly its depth. As boiler and grate are now located in respect to one another in the ordinary boiler, the difference between a thick or a thin firebed may cause the economical or uneconomical consumption of fuel. The difficulty of keeping a thin firebed in proper condition is far greater than that of maintaining a thicker layer of fuel in the right condition, so the "human element" is tending continually towards a more wasteful use of fuel.

The cause of this inefficiency lies almost entirely in the failure of the boiler manufacturer, the operator and the management to understand or to realize the importance of understanding the diametrically opposite functions of the boiler and of the furnace. The use of the latter is to develop a maximum of heat from the combustion of the fuel on the grates and, to accomplish this, complete combustion of all combustible material is necessary. The duty of the boiler, on the other hand, is to absorb as much of this heat as possible, and in doing so it must, of necessity, tend to reduce the temperature of the products of combustion that are the conveyors of the heat.

Comparatively speaking, the boiler and its contents are relatively cold, while the furnace gases are hot. As the temperature of the furnace gases,—the products of combustion,—are dependent upon the completeness of their combustion, and as the rate of heat absorption by the boiler is also directly dependent upon the temperature of these gases, it must be evident that the best efficiency of the boiler can be realized only when complete combustion takes place in the combustion chamber.

In order that this condition may exist, the volatile gases driven off from the coal must be allowed to ignite before their temperature is in any way reduced; in fact, a comparatively slight reduction in their temperature will prevent some of them from igniting and will prevent the fine particles of carbon that are driven off from combining with the oxygen in the combustion chamber—and, as hot gases and vapors rise at a rate proportional to their temperature, there must be sufficient distance between the firebed and the boiler to allow for their complete expansion and ignition before the lower surface of the boiler proper is reached. Soft coals containing a large proportion of volatile matter require considerably more space between the grate and the boiler than the more stable anthracite coals, a fact that is continually being emphasized and drawn to the attention of the manufacturer, the operator, and the management by the greater difficulty of burning soft coal smokelessly. Radiation losses being comparatively small from any well set boiler, it seems almost inex-

cusable to err continually in placing the furnace grates too close to the boiler, for the hot gases of combustion would rise a considerable distance in a properly insulated combustion chamber before losing any appreciable amount of heat. Erring in the other direction by having the boiler set farther away from the grates than necessary would be far less harmful, as far as economical use of fuel is concerned, than the almost universal custom criticized.

Insertion of baffle walls and bridges cannot increase the degree of ignition and expansion in the combustion chamber, as once the products of combustion come in contact with any metal part of the boiler, their temperature commences to be reduced and the gain in boiler efficiency brought about by such practice, due to keeping the gases of combustion in contact with the charged parts of the boiler for a longer period, can be only a proportion of that which could be realized in the average installation if the combustion chamber was so proportioned as to assure complete combustion of all products before they come in contact with the relatively cool and heat-absorbing boiler.

At the same time that the boiler efficiency was thus improved, the smoke nuisance, so common when burning volatile coals in particular, would be entirely overcome; for, with complete combustion, brought about almost entirely by the deeper combustion chamber, no free carbon would remain to form the black and wasteful smoke.

An indirect saving that would also accrue from correctly proportioning the combustion chamber would be that of greatly simplifying the work of the firemen, where hand firing is used, and, where automatic stokers are employed, presenting more favorable conditions for their satisfactory operation.

Meeting of the N. D. H. A.

SIXTH ANNUAL CONVENTION, MAY 26-29, ROCHESTER, N. Y.

AT THE annual convention of the National District Heating Association, held in Rochester, N. Y., at the Seneca Hotel, many papers were presented and subjects pertaining to the industry of heating from central stations were discussed, which proved of considerable interest and value to the men in attendance. The research of the various committees which has been carried out during the past year has resulted in the collection of a vast amount of information which is now available to engineers interested in heating buildings of all classes, especially by means of the central station.

The meeting was opened with an address of welcome by Commissioner of Public Safety, Charles S. Owen, which was responded to by Fred B. Orr, of Chicago. The president, S. Morgan Bushnell, of Chicago, then gave his address, which consisted principally of a brief account of the developments of central station or district heating, giving some of the reasons for the origin and growth of this association. He stated that some have hoped that steam and hot water systems of heating might eventually be displaced by electrical heating, and that the ultimate solution of the problem would be a general one of electricity for heat, light and power. It was his opinion, however, that a glance at a few statistics would eliminate this idea in the mind of all engineers.

UNDERGROUND CONSTRUCTION

THE REPORT of the Underground Construction Committee was read by H. A. Woodworth, of Indianapolis, Ind., chairman, and dealt with the subject only in a general and brief manner. It was stated that district heating is standardized as regards the station, but is only approaching standardization on the underground construction.

The committee outlined the procedure for the construction of underground heating systems, step by step, giving in detail each operation, the obstacles which are liable to be met, and the best methods for overcoming difficulties. Tunnel construction was then discussed, and a summary of investigation concluded the report. In regard to line losses, the committee states that these pipe line losses are caused principally by radiation and leaks. Particular emphasis was laid upon the reduction of losses due to steam or hot water leaks. Other sources of operating waste were pointed out as blowing steam traps, leaky expansion joints, city water leaks over or near the heat mains, and electrolysis. The line losses for underground steam mains have been found by metering the main line, measuring the condensation per hour, per day, and per month, and determining the losses under various conditions.

METERING HEAT

A. D. SPENCER, CHAIRMAN of the Meter Committee, read the report of that committee, which consisted principally of descriptions of new devices, and some data on the performance of steam flow and condensation meters. During the past year, one of the members conducted a series of tests on condensation meters, to determine some of the characteristics. The results of these tests were presented and demonstrated very forcibly the necessity of protecting condensation meters from direct steam pressure if accurate registration is desired. It was recommended that all traps be kept in first-class condition, continuous flow traps should be used, rather than the dumping types, as the latter discharge the condensation in surges and frequently with considerable pressure. In cases where conditions are unusually severe, and it is impossible to keep the traps from blowing, some sort of protection should be installed between the traps and the meter. Among the devices which have been used for this purpose, are the receiving tank and the muffler.

In an address upon Public Policy of Utilities, by R. M. Searle, of the Rochester Railway and Light Co., a plea was made for a service of such a character that it would not only receive public support, but would encourage all capital to come in and develop it. He said that, to avoid extravagance everyone had to pay for, a study must be made of human nature and local situation.

The report of the Station Record Committee was read by Chairman A. P. Biggs, of Detroit, Mich. The work

of the committee during the past year, has been the compilation of several forms submitted by members of the association, and binding them into one volume which consists of 250 forms, and was on exhibit for the inspection of members.

Discussion on Pumps

Expense of operating centrifugal pumps vs. double-acting pumps was the subject of a discussion led by A. C. Rogers, of Toledo, O. He stated that during the past 5 yr. the centrifugal pump has made wonderful strides, but that the limit of what it will do has not been reached. Good work can be had from a reciprocating pump, but to underestimate the size of the recip-recoating pump, is a common fault either due to space or money, which results in an increased cost for maintenance, the valves will be hammered out, and the packing will give way. Investigation has not been carried out to the point where one can say that either pump will displace the other. Both pumps have admirable qualities, and each is particularly fitted for certain usefulness against the other.

H. A. Woodworth stated that the Merchants' Heat & Light Co., of Indianapolis, replaced a large reciprocating pump on one of its hot-water systems, supplying about 400,000 ft. of radiation with a centrifugal motor-driven pump, the idea being at the time that it would increase the pipe line capacity, on account of the reciprocating pump not being able to take care of the flow. After the centrifugal pump was installed, the same amount of water was circulated; but it was found that a better differential at the end of the line was secured, and it has eliminated practically all of the troubles without having to change the pipe line. This arrangement has increased the capacity 15 to 20 per cent.

Superheated Steam for Heating

Davis S. Boyden, of Boston, discussed the effects of superheated steam on heating systems. He stated that with steam at 5 lb. pressure and 100 deg. superheat, the effect of superheating will increase the available heat 5.1 per cent; will increase the volume of steam 14 per cent, and will increase the distribution losses due to condensation 64 per cent. It must be realized, however, that condensation in well insulated pipes is small—the 64 per cent increase will affect only this loss and not the whole quantity of steam flow.

Considering economy alone, the advantages seem to be slightly with the superheated steam when the system is such as to warrant its use, and properly designed for its application.

Calculating Heat Losses

In his paper on Heat Losses from Buildings of Latest Construction, J. Byers Holbrook gives the following values for various materials composing buildings, the following coefficient (K), which represents the loss by transmission per square foot of surface in B.t.u. per hour for each degree difference of temperature on the 2 sides of the material:

(a) Solid brick wall, 21 in. thick.....0.187
(b) Hollow brick wall, 21 in. thick.....0.160
(c) Solid granite or marble wall, 21 in. thick..0.315
(d) Hollow granite or marble wall, 21 in. thick.0.255
(e) Brick wall with standstone faces, plastered on inside, 12-in. brick and 9-in. sandstone 0.160
(f) Concrete wall, 21 in. thick.....0.350

The above constants are for walls furred and plastered on the inside with 2-in. terra cotta or wood furring. For walls not furred or plastered, it is well to add 20 per cent. For ceilings, assuming temperature of attics as 30 deg. above the lowest outside temperature.

(g) Fireproof ceiling (metal lath, no wood above) 0.49
(h) Fireproof ceiling (metal lath, wood floor above) 0.15

For glass surfaces:

(i) Glass in single windows.....1.00
(j) Glass in double windows.....0.50

Mr. Holbrook uses the following formula for direct radiating steam heating system:

$$R = \tfrac{1}{3} G + 0.08 W + 0.006 V.$$

in which R = radiation surface in square feet required,
G = glass surface in exposed walls,
V = volume of room in cubic feet (assuming one air change per hour in the average office building rooms).

For other forms and types of heating systems, the following increases are recommended:

Gravity hot water heating.....	60%
Regular vapor heating.....	10 to 20%
Hot water, forced circulation heating.....	25 to 35%
Indirect steam heating.....	50 to 60%
Direct-indirect steam heating.....	25 to 30%
Recessed or boxed-in steam radiators.....	20 to30%

Intermittent Service

Whether it is More Profitable to shut off Steam at Night or to keep it on Continuously, was the subject of a discussion lead by E. L. Wilder, of Rochester, N. Y. There can be no general answer to this question, he states, that will apply to all conditions. More is involved than simply the question as to how much steam will be used, or how much coal will be burned. In general, the method of operation which uses the least steam will be the most profitable, but it is not necessarily the case.

The application of this method of running a heating system depends a great deal upon the rapidity with which heat must be supplied when it is desired to bring the temperature normal. The result of observations on the operation of heating systems of several factory buildings, which are being heated by central station steam service, has led to the conclusion that a saving of from 10 to 30 per cent may be effected by the method of intermittent heating.

Heating Rates

The report of the Rate Committee was read by E. L. Wilder, chairman, who stated that the conditions around the country under which steam heating companies do business, vary greatly, both as to investment required, operating costs and load factor. No particular rates, therefore, were recommended, but the general principles of rate making and recommendations as to the method of determining rates were discussed. The fundamental elements entering into a rate determination were stated as cost of service and competitive cost.

In the case of hot-water heating plants, because of the lack of a suitable meter for measuring the service rendered, but one charge can be made. This charge is essentially a demand charge based upon the calculated heating requirements, and is the method ordinarily employed. In the case of steam heating service, the charge may be divided into 2 parts, one a charge proportional to the steam demand, and the other proportional to the amount of steam consumed.

The fundamental object of a 2-rate charge as presented, is to fit the charge to the cost of service.

The accompanying table is that used by W. H. Schott, and represents the coefficient for estimating radiation based on outside temperature of 10 deg. below zero, and inside temperature of 70 deg.

COEFFICIENTS FOR ESTIMATING RADIATION BASED ON OUTSIDE TEMPERATURE OF 10 DEG. BELOW ZERO AND INSIDE TEMPERATURE OF 70 DEG.

	B.t.u. 1 deg. Dif.	Square ft. radiation to sq. ft. exposure Vapor or Atm. Steam	L.-P. Steam	Hot Water 180° to 0°
Single glass, loose	1.50	.500	.430	.705
Single glass, medium	1.35	.450	.390	.638
Single glass, tight	1.20	.400	.340	.564
Double window (storm)	.60	.200	.170	.285
Vault glass (sidewalk)	1.50	.500	.430	.705
Single sky-light glass	1.08	.360	.310	.508
Double sky-light glass	.60	.200	.170	.282
Good door, half glass	.69	.230	.200	.327
Good door, solid	.48	.160	.140	.226
Poor frame wall, N. & W.	.45	.150	.130	.214
Poor frame wall, S. & E.	.42	.140	.120	.197
Average frame wall, N. & W.	.42	.140	.120	.197
Average frame wall, S. & E.	.38	.130	.110	.180
Frame, back plastered, N. & W.	.33	.110	.094	.158
Frame, back plastered, S. & E.	.30	.100	.085	.141
8-in. brick wall, N. & W.	.39	.130	.110	.186
8-in. brick wall, S. & E.	.35	.120	.100	.163
12-in. brick wall, N. & W.	.30	.100	.085	.141
12-in. brick wall, S. & E.	.27	.090	.077	.130
17-in. brick wall, N. & W.	.24	.080	.069	.113
17-in. brick wall, S. & E.	.22	.070	.060	.101
Ceiling—floor above	.15	.025	.022	.0338
Floor—not plastered beneath	.30	.050	.043	.073
Partition—plastered both sides	.20	.030	.026	.045
Cubic contents—				
½ change per hour	.009	.003	.003	.0045
1 change per hour	.018	.006	.005	.0085
2 changes per hour	.036	.012	.010	.0169

Customers' Installations

H. R. Wetherell, of Peoria, Ill., presented a paper entitled Customers' Steam Heating Systems, in which he stated the customers' heating systems, if installed in the proper manner, is one of the greatest assets to the district heating company. A few of the heating companies are now insisting on making the plans and specifications for all such systems.

The writer described a few systems which are in general use in buildings connected to district heating plants and explained his methods of overcoming difficulties resulting from serving several different types of heating systems.

Geo. W. Martin, of the New York Service Co., read a paper entitled Commercial Steam Heating in New York City. This was a record of the experience of a company operating a number of individual plants in New York City, giving difficulties encountered in the operation of several plants, presenting record forms used and the methods of calculating actual heat requirements of buildings.

Recommendations and Investigations

The Educational Committee, consisting of Davis S. Boyden, Boston; C. R. Bishop, North Tonawanda; E. F. Capron, Chicago, and G. E. Chapman, Oak Park, Ill., presented an extensive report making recommendations for the adoption of standards for the measurement of steam heat, dimensions of flange fittings, and the results of several investigations which were carried on by different members of the committee and members of the association.

The unit of measurement for the sale of steam is the pound. Steam meters measuring the quantity of steam passing into the installation, or condensation meters measuring the pounds of steam condensed in the installation may be used. The American Standard dimensions for flanges and flange fittings was that recommended by the committee, and a copy of the explanatory notes were presented for the consideration of members of the association.

One of the investigations carried out and presented in the report was on weather-stripping and its effect on air leakage and radiation of buildings, which resulted in the conclusion that for all practical purposes, 1 mi. of wind movement per hour is equal to 1 deg. drop in temperature; while, if openings are effectively protected, 1 mi. of wind is equal to only 0.4 of a degree drop. The effective weather stripping of buildings reduces the factor used for leakage and wind effects on the average building about 60 per cent. Thus, when buildings are so equipped with weather stripping, the amount of radiation is approximately 10 to 15 per cent less.

The report included rules and regulations for first aid to the injured, which have proved of great value in the prevention of accident in power plants and factories.

The test of a low-pressure steam vegetable cooker was also included in this report, as was also an analysis of the effect of meteorological conditions on heat output of a district heating plant.

The Station Operating Committee, consisting of Byron T. Gifford, Grand Rapids, Mich., chairman; O. C. Irwin, Berlin, Wis.; R. V. Parkinson, deceased, Chicago, Ill.; E. M. Carr, Indianapolis, and A. J. Authenreith, Mattoon, Ill., took up the subjects of boilers and general operation conditions, and covered them in a broad and comprehensive manner. The report, which consisted largely of a number of articles written by men of recognized standing upon the various subjects pertaining to the operation of stations, is too lengthy to give more than a brief mention at this time, but an abstract will be published in an early issue.

The officers elected for 1915-1916 are as follows: President, H. R. Wetherell, Central Illinois Light Co., Peoria, Ill.; first vice-president, D. S. Boyden, Boston Edison Illuminating Co., Boston, Mass.; second vice-

president, B. T. Gifford, American Public Utilities Co., Grand Rapids, Mich.; third vice-president, George W. Martin, New York Service Co., New York, N. Y.; secretary and treasurer, D. L. Gaskill, Greenville, O.; executive committee, S. Morgan Bushnell, Chicago, Ill.; H. Almert, Chicago, Ill.; C. F. Oehlman, Denver Gas and Electric Co., Denver, Colo.

Relaxations

Interspersed with business throughout the entire convention were entertainment features which were enjoyed by members and ladies in attendance. On Friday, the entire day was given over to entertainment as the guests of the American District Steam Co. A special train of Pullman cars took the party of 150 delegates ladies and exhibitors from Rochester to Lockport, former headquarters of the A. D. S. Co., here autos carried the guests for an hour through this beautiful city, where things of interest were pointed out. The party assembled at the new plant of the A. D. S. Co. in North Tonawanda, where lunch was served. After a tour through the factory, the special train carried the party to Niagara Falls. A banquet was served in the Hotel Clifton, Canada, followed by dancing. The party returned by way of Buffalo to Rochester at a late hour.

Exhibitors at Sixth Annual Convention N. D. H. A.

THE HOHMAN and Maurer Division, Taylor Instrument Companies, Rochester, N. Y., had an exhibit of Tycos recording thermometers and Tycos index thermometers, as well as condenser, superheated steam and flue gas thermometers, all arranged on exhibition boards. Their display also included mercury vacuum gages, mercury absolute pressure gages and an electric distance reading thermometer outfit. L. B. Swift, of the home office, was in charge of the exhibit.

Armstrong Cork Co., of Pittsburgh, Pa., had a complete exhibit of Nonpareil high pressure coverings, cement, high pressure blocks and Nonpareil insulating brick, also diagrams and photos of underground steam lines. The company was represented by Thos. L. Hortman and E. L. Long of the Rochester office.

American District Steam Co., of North Tonawanda, N. Y., had an interesting display of its complete line of equipment, including a model of the American Underground System of District Heating and models of fittings and accessories, also a section of standard steam pipe casing and wood water pipe. A full size condensation meter was on exhibit, disassembled for inspection. Chas. R. Bishop, R. C. Halley, Robert Hall, W. H. Wells, H. H. Austin, C. J. Dudley, Lloyd Howell, C. A. Gillham, H. Kirrbrough, W. J. Kline and C. S. Williams represented the company.

The Bigelow Co., New Haven, Conn., showed a model Bigelow-Hornsby boiler and distributed an attractive catalog, being represented by S. H. Barnum, from the New Haven office.

National Air Cell Covering Co., Brooklyn, N. Y., had an exhibit of samples of Pyro-Bestos sectional pipe covering for underground or exposed steam or hot water pipe. The exhibit was in charge of C. G. Hall.

The Michigan Pipe Co., Bay City, Mich., had a well arranged exhibit of Michigan tin-lined wood casings for insulating underground steam and hot water pipes and Michigan combination steel and wood water pipe. The company was represented by H. B. Smith, Jr.

A. Wyckoff & Son Co., Elmira, N. Y., had an interesting display of Wyckoff's steam pipe covering for hot water and low pressure steam pipe, also tin-lined covering for high pressures. Specimens of their underground pipe were also to be seen. Peter O. Sutphen, of the Elmira office, explained the merits of the line, and handed out some interesting literature.

Central Station Steam Co., Detroit, Mich., had its condensation meter in operation. Service separators and diaphragm expansion joints were also exhibited. J. V. Redfield, F. A. Green and W. R. Owen represented the company.

The V. D. Anderson Co. exhibit was in charge of Joseph H. Meyer, of Detroit, Mich. He ably explained the features of the Anderson Model D steam trap, separator, column, air trap and floats.

Jenkins Brothers, of New York City, displayed a line of full-sized valves and the exhibit was in charge of Chas. F. Beckwith, of the New York office.

Warren Webster & Co., Camden, N. J., was well represented by not only a complete line of radiator valves, strainers, vacuum valves, governors, regulators and feed-water heaters, but also by their assistant general manager, John F. Hale. He was assisted by F. H. Montrueil.

H. W. Johns-Manville Co., New York City, had on exhibition an interesting model, showing section of the J-M section underground conduit for steam and hot water systems, also a full line of samples of pipe and boiler covering, packing and gaskets. Representing the company were Wm. McElraevy, New York; F. J. Medway, New York; L. Lindsay, Rochester office, and K. R. Shadek, Buffalo office.

The following concerns did not have exhibits, but were represented:

Wm. Powell Co., Cincinnati, O., by W. J. Leonard, of Buffalo; Westinghouse Machine Co., Pittsburgh, Pa., by R. J. Barker, of Rochester, and L. S. Shaw, of Chicago; Tyler Underground Heating System, by E. B. Tyler; General Electric Co., Schenectady, N. Y., by H. C. Ward, of Rochester; B. F. Sturtevant Co., Hyde Park, Mass., by J. T. Williamson, of Rochester; Connelton Sewer Pipe Co., Connelton, Ind., by Chas. A. Clemens; Westinghouse Church, Kerr Co., New York City, by H. C. Pond; Thermograde Valve Co., by Wm. T. Jones, of Boston; National Tube Co., Pittsburgh, by H. S. Patterson, of New York, and D. R. Mason, of Pittsburgh; Ric-Wil Underground Pipe Covering Co., Cleveland, O., by C. Gottwald, of Cleveland, and C. M. Stokes, of Norristown Covering Co., Norristown, Pa.; Westinghouse Elec. & Mfg. Co., Pittsburgh, by A. Tobias, Pittsburgh; Chamberlain Weather Strip Co., by H. W. Whitten, Boston; Heating and Ventilating Magazine, New York City, by H. S. Armagnac, of New York; Electrical World, New York, by W. E. Keily; Heat, Detroit, Mich., by L. A. Pratt; Practical Engineer, Chicago, Ill., by C. B. Leech, of Cleveland; Power, New York, by F. Van Winkle; Domestic Engineering, Chicago, by E. D. Winslow.

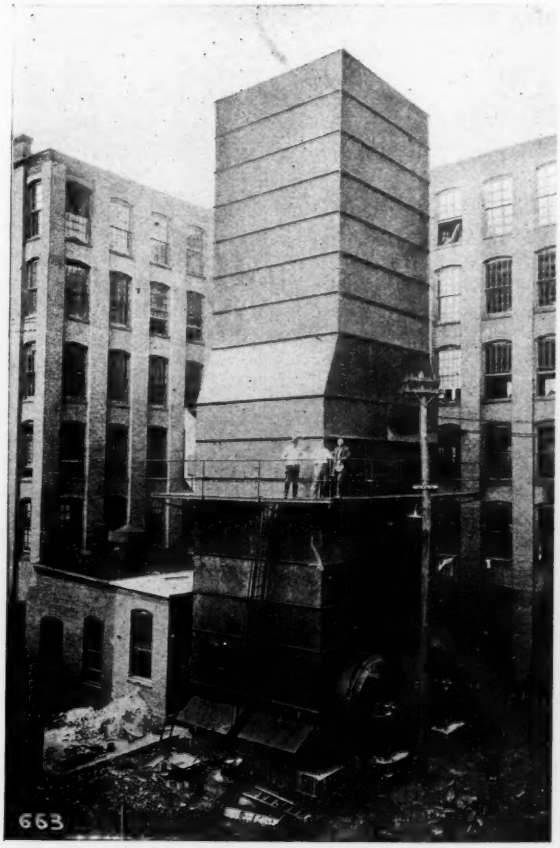
Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Large Wheeler-Barnard Cooling Tower

ACCOMPANYING photograph illustrates a large twin Wheeler-Barnard forced draft cooling tower recently completed by the Wheeler Condenser & Engineering Co. for the American Hardware Co. at its New Britain, Conn., plant. The capacity is 132,000 gal. per hr., cooled from 100 to 80 deg.

The tower proper terminates just above the platform on which the men are standing, the steel plate work above this being a stack to convey vapors above the roof



COMBINED FORCED AND NATURAL DRAFT COOLING TOWER

of the building, and also to provide natural draft for operation in cold weather. The tower is designed with special air inlets, which are opened when the fans are not in use, and the stack supplies the draft. They consist of counterweighted doors, which, when opened as shown in the picture, provide a large area for the inlet of air.

The unit consists of 2 towers arranged side by side, each 11 ft. 5 in. wide and 18 ft. 3 in. long, erected over a reservoir, which also serves as foundations. The chimney is 18 ft. 3 in. square and the height from the base of the tower to the top of the stack is 70 ft. Forced draft is supplied by 4 108-in. fans.

Morrison Water-Tube Boilers

IN this boiler, which is shown assembled, in Fig. 1, and in sectional views, in Fig. 2, the flow of hot gases is in the longitudinal direction of tubes and drums, with the combustion chamber placed at the end of the drums. This gives a circulation of gases lengthwise of the tubes, and a circulation of water lengthwise

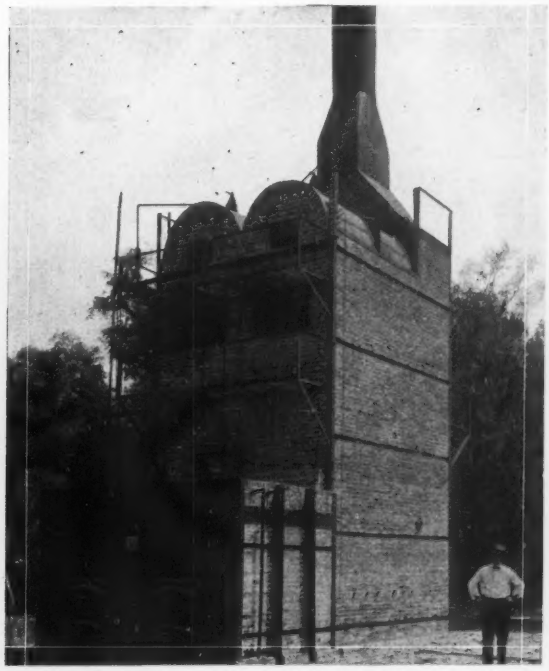


FIG. 1. BATTERY OF 2 MORRISON BOILERS

through the drums and vertically in the tubes between drums, without passing through cross-connecting tubes.

From a study of Fig. 2, it will be seen that the gas passages between tubes are of uniform cross-section at all points, so that no cross baffles are necessary, and the longitudinal baffles are not carried by the tubes, but are entirely independent of them, having sufficient

space so that they are made heavy and substantial, 9 in. thick, of common shapes of fire brick.

As shown in Fig. 2-A, the tubes are so arranged in the drums, by staggering the 2 intermediate rows in each bank with the center row, that wide spaces are left alternately in the outside rows, and the center tubes may thus be removed through either a right or a left-hand space, and the tubes in the intermediate rows can also all be removed through these same spaces, so that any tube may be replaced without disturbing any other tube or the baffle wall. The weight of the boiler is carried on saddles under the bottom drums, and does not rest either upon the framework or the brickwork. The boiler is surrounded with a brick setting, which may be covered with a sheet-iron casing, if desired.

By the nature of the construction, no stays or stay-bolts are used, and the curving of the ends of the tubes makes it possible to fit these into the drums by the usual method of expanding the ends, without the use of special forms of drums, bolts or gasket joints.

The units shown, are of the 5-row type, as illustrated in the cross section, and of 200 hp. each, in the plant of the National Pulp and Turpentine Co., at Green Cove Springs, Fla. By using longer drums, and more rows of tubes, larger units may be built as desired. The boiler is manufactured by the Morrison Boiler Co., of Sharon, Pa.

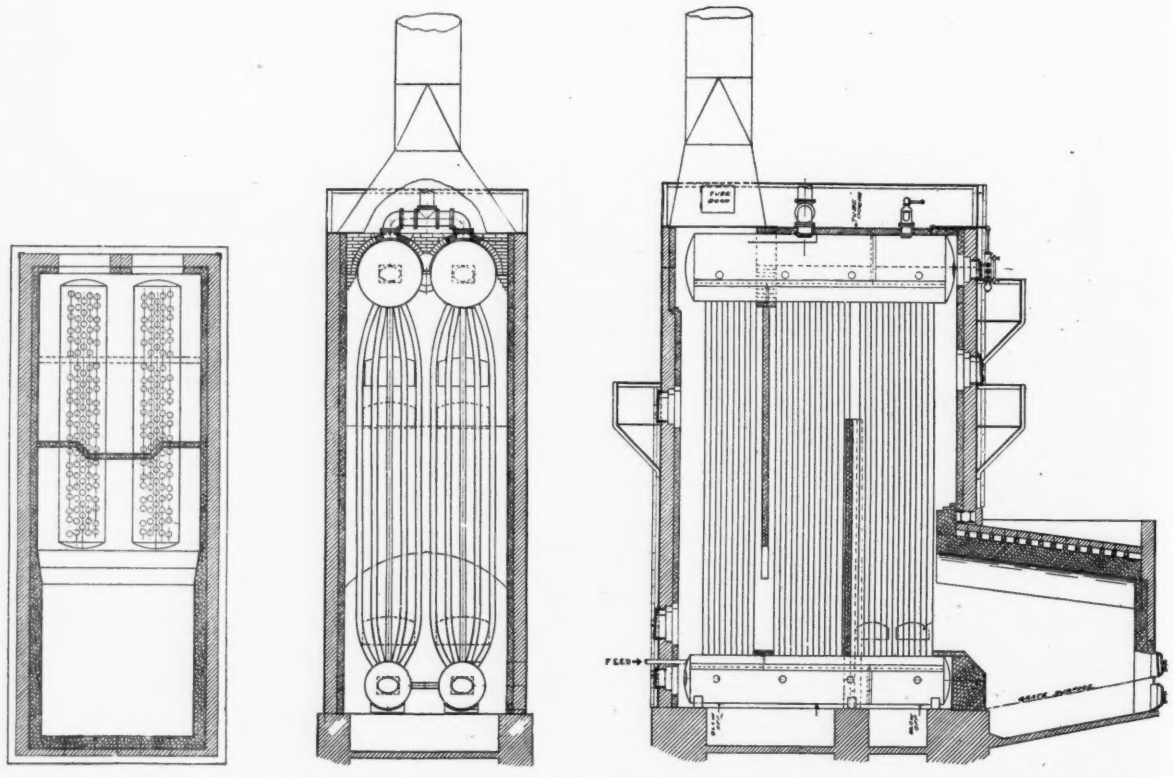


FIG. 2. SECTIONAL VIEWS OF MORRISON BOILER; A, PLAN AT TUBE SHEETS; B, END SECTION; C, SIDE SECTION

CONSTRUCTION OF the electric light plant at Camden, Tenn., goes on rapidly. J. S. Maday & Son, of Mayfield, hope to have it in full operation by July 1.

Success in Profit-Sharing

IN its efforts to reduce manufacturing costs, and at the same time increase the amount paid to employes, the Clipper Belt Lacer Co., of Grand Rapids, Mich., adopted at the end of 1912, a profit-sharing plan, combined with a piece work system. Accurate records of costs had been kept for every operation, so that there was a satisfactory basis for making the piece work prices, and, in fact, previous to that time, part of the work had been put on a piece basis, with satisfactory results to both company and employes. At the same time, a 9-hr. working day, with Saturday half-holiday, was adopted for the entire year, and the profit-sharing was established on the following basis:

Employes who at the end of 1913 had been with the company one year only, were to receive 5 per cent in cash of the amount paid them in wages during the year; those 2 yr. with the company were to receive 6 per cent, 3 yr. 7 per cent, and so on, one per cent being added for each year of continuous service, until the amount reached 10 per cent, which was the maximum for the profit-sharing. The condition was made that the profits for each year must warrant this percentage of payment.

On closing the books for 1913, it was discovered that over $3000 was available for distribution under the profit-sharing plan, and that 2 employes had earned the maximum 10 per cent dividend. These dividends, or shares, were placed in the pay envelopes on Christmas eve, and the instances in which this amount proved of

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps

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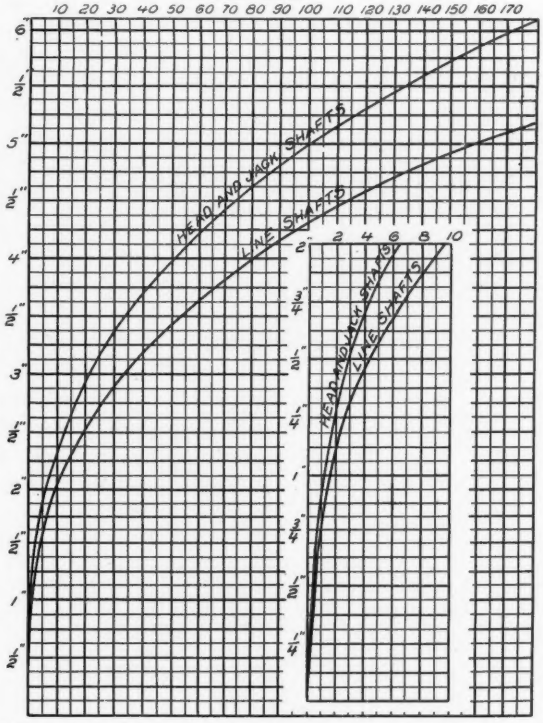
PRACTICAL ENGINEER

CHART I. HORSEPOWER CAPACITY OF STEEL SHAFTING AT 100 R.P.M.


HORSEPOWER
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170
DIAMETER OF SHAFT
HEAD AND JACK SHAFTS
LINE SHAFTS
2 4 6 8 10

PRACTICAL ENGINEER

TABLE I. COST OF INSTALLATION, DOLLAR PER KILOWATT

Items	Size of Plants—Kilowatts					
	500	1000	2000	3000	4000	5000
Building, real estate and excavating	16.75	14.50	13.25	12.00	11.00	10.00
Turbines and generators	32.60	25.75	21.15	17.30	15.80	15.00
Condensers	10.60	6.75	4.50	3.90	3.50	3.00
Boilers, stokers, superheaters and stacks	32.65	28.50	25.50	23.60	21.50	20.00
Bunkers and Conveyors	5.50	5.00	4.50	4.00	3.50	3.25
Boiler feed and service pumps	1.25	1.25	1.00	0.75	0.50	0.50
Feed water heaters	2.00	1.75	1.50	1.25	1.00	0.80
Switchboard and wiring	3.50	3.25	3.25	3.00	2.75	2.75
Exciters	4.00	3.00	2.00	1.50	1.00	0.75
Foundation (machinery)	1.25	1.25	1.00	1.00	0.75	0.75
Piping and conduits	5.75	5.75	6.00	6.00	6.25	6.25
Crane	1.65	1.75	1.50	1.25	1.00	0.75
Superintending, engineering, etc.	6.50	5.00	4.25	3.75	3.25	3.00
Total	123.60	103.50	89.40	79.30	71.80	66.80

TABLE III. COST OF INSTALLATION PER KILOWATT FOR 1000-KILOWATT PLANT

Plant	Cost per kilowatt
Turbine	$103.50
Reciprocating steam engine	132.50
Combination reciprocating engine and turbine	127.00
Gas engine	162.50

PRACTICAL ENGINEER

PIPE SIZES FOR 2-PIPE STEAM HEATING GRAVITY SYSTEM

Steam Main	Sq. Feet of Heating Surface	Dry Return	Wet Return
1 in. pipe	40	¾ in.	¾ in.
1¼ in. pipe	75	1 in.	¾ in.
1½ in. pipe	126	1 in.	1 in.
2 in. pipe	286	1¼ in.	1 in.
2½ in. pipe	535	1½ in.	1 in.
3 in. pipe	890	1½ in.	1 in.
3½ in. pipe	1,360	2 in.	1 in.
4 in. pipe	1,950	2 in.	1 in.
5 in. pipe	3,600	2½ in.	1¼ in.
6 in. pipe	5,900	3 in.	1½ in.
8 in. pipe	12,700	4 in.	2 in.
10 in. pipe	22,900	5 in.	2½ in.
12 in. pipe	37,000	6 in.	3 in.
14 in. pipe	55,300	7 in	3½ in.
16 in. pipe	78,300	8 in.	4 in.

N. D. H. A.

PRACTICAL ENGINEER

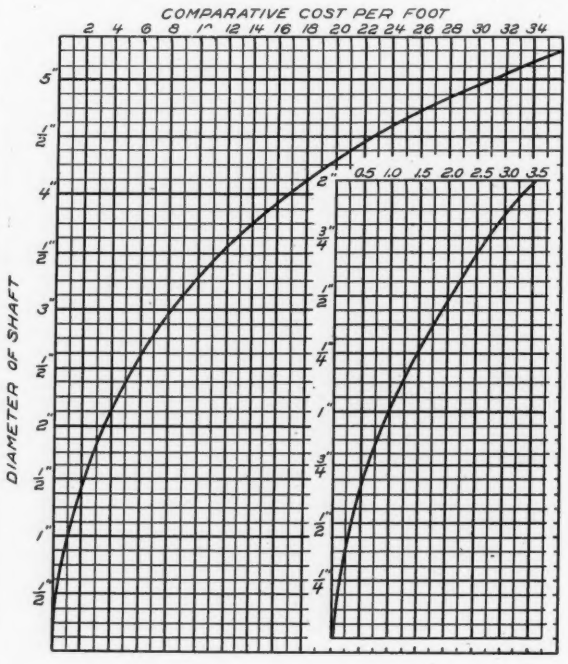
TABLE IV. COST OF PRODUCING POWER

1000 Kilowatt Plants	Fuel	Labor	Oil Waste and Supplies	Repairs and Maintenance	Operating Cost	Fixed Charges	Total
100 Percent Load-Factor.							
Turbine	0.364	0.094	0.019	0.021	0.498	0.124	0.622
Reciprocating steam engine	0.390	0.105	0.023	0.024	0.542	0.166	0.708
Combination recip. and turbine	0.340	0.110	0.025	0.025	0.500	0.158	0.658
Gas engine	0.260	0.165	0.033	0.335	0.483	0.213	0.706
75 Percent Load-Factor.							
Turbine	0.429	0.116	0.025	0.026	0.593	0.165	0.758
Reciprocating steam engine	0.461	0.128	0.028	0.030	0.647	0.222	0.869
Combination recip. and turbine	0.404	0.134	0.030	0.032	0.600	0.211	0.811
Gas engine	0.334	0.195	0.039	0.044	0.612	0.285	0.897
50 Percent Load-Factor							
Turbine	0.558	0.166	0.033	0.035	0.792	0.248	1.040
Reciprocating steam engine	0.602	0.182	0.039	0.040	0.863	0.332	1.195
Combination recip. and turbine	0.527	0.189	0.042	0.043	0.801	0.316	1.117
Gas engine	0.482	0.252	0.052	0.055	0.841	0.426	1.267

TABLE II. COST OF POWER GENERATION; COAL $3 A TON; PRESSURE 175 LB., SUPERHEAT 100 DEG. F., VACUUM, 28 IN.

Size of Plant Kilowatts	Cost in Cents per Kilowatt-Hour						
	Fuel	Labor	Oil Waste and Supplies	Repairs and Maintenance	Operating Cost	Fixed charges	Total
100 Percent Load-Factor							
500	0.449	0.132	0.026	0.025	0.632	0.148	0.780
1000	0.364	0.094	0.019	0.021	0.498	0.124	0.622
2000	0.328	0.073	0.015	0.018	0.434	0.107	0.541
3000	0.304	0.065	0.013	0.016	0.398	0.095	0.493
4000	0.289	0.058	0.011	0.014	0 372	0.086	0.458
5000	0.271	0.053	0.010	0.013	0.347	0.080	0.428
75 Percent Load-Factor							
500	0.548	0.166	0.033	0.031	0.778	0.197	0.973
1000	0.428	0.116	0.023	0.026	0.593	0.165	0.758
2000	0.389	0.088	0.019	0.021	0.517	0.143	0.660
3000	0.352	0.079	0.016	0.019	0.466	0.127	0.593
4000	0.327	0.072	0.014	0.017	0.430	0 115	0.545
5000	0.308	0.065	0.013	0.016	0.402	0.107	9.509
50 Percent Load-Factor							
500	0.741	0.236	0.047	0.042	1.066	0.296	1.362
1000	0.558	0.166	0.033	0.035	0.792	0.248	1.040
2000	0.494	0.118	0.024	0.030	0.666	0.214	0.880
3000	0.438	0.106	0.021	0.027	0.592	0.190	0.782
4000	0 402	0.097	0.019	0.024	0.542	0.172	0.714
5000	0.380	0.088	0.017	0.022	0.507	0.160	0.667

CHART II. COMPARATIVE COST OF FINISHED STEEL SHAFTING. COST OF 1-IN. SHAFT = 1



FUEL COST FOR POWER IN ENGLAND

From an article in Engineering are taken the following costs for power in England for various classes of prime movers. For steam plants, coal is $3.15 a ton, evaporation 7.5 lb., mechanical efficiency of steam engine 90 per cent, and efficiency of turbine generator 94 per cent. Superheat used as found most desirable. Fuel for gas engines includes standby producer losses.

Hp. of Prime Mover	lb. per hr.	Fuel Used	Fuel Cost, Cents		Fuel Price
Steam Engine					
	Steam Hp.-hr.	Lb. I. Hp.-hr.	I. Hp.-hr.	B.Hp.-hr.	
250 I. Hp.	13.3	1.78	0.246	0.274	$3.15 per ton
1000 I. Hp.	11.97	1.60	0.222	0.246	$3.15 per ton
Steam Turbine					
	Steam per Kw.-hr.	Lb. Kw.-hr	Kw.-hr		
1000 I. Hp. 670 Kw.	15.1	2.02	0.28	0.222	$3.15 per ton
2000 I. Hp. 1250 Kw.	13.85	1.85	0.258	0.204	$3.15 per ton
5000 I. Hp. 3500 Kw.	13.6	1.82	0.252	0.2	$3.15 per ton
Diesel Engines					
	Oil per B. Hp. hr.				
120 B. Hp.	0.44			0.424,	$21.83 per ton
Gas Engines					
	Cu. ft. B. Hp.-hr.				
City Gas 600 B.t.u.	14.9			0.626	$0.4225—1000 cu. ft
Anth. Suction	1 lb.			0.386	$8.73 per ton Anth.
Bit. Producer	1.3 lb.			0.168	$2.91 per ton Slack

PIPE SIZES FOR HOT WATER HEATING MAINS

Diameter of Pipes	Two Pipe Up Feed Direct Radiat'n	One Pipe Up Open Tank Direct Radiat'n	Overhead Open Tank Direct Radiat'n	Overhead Closed Tank Direct Rad'n	"Two Pipe Open Tank Indirect 12" above boiler
1¼	75	45	127	250	48
1½	107	65	181	335	69
2	200	121	339	667	129
2½	314	190	533	1,060	202
3	540	328	918	1,800	348
3½	780	474	1,334	2,600	502
4	1,060	645	1,800	3,350	684
5	1,860	1,130	3,150	6,200	1,200
6	2,960	1,800	5,000	9,800	1,910
7	4,280	2,700	7,200	13,900	2,760
8	5,850	3,500	8,900	19,500	3,778

SIZES FOR HOT WATER RISERS

Diameter of Pipes inches	Open Tank System 1st Floor	2nd Floor	3rd Floor	4th Floor	Closed Tank System Closed System Not Drop Risers exceeding 4 floors
1	33	46	57	64	48
1¼	71	104	124	142	112
1½	100	140	175	200	160
2	187	262	325	375	300
2½	292	410	492	580	471
3	500	755	875	1,000	810

N. D. H. A.

considerable assistance to the workers were numerous. The result has been a yearly output nearly doubled, with only a slight increase in the working force, a reduction in the manufacturing cost of the Clipper belt lacer of 9 per cent, while the men increased their earnings 20 per cent, and hearty cooperation of operatives with the company in all matters.

As a result of the year's experience, the plan will be continued in force indefinitely, and will unquestionably work for the retention of employes, as their dividends will increase with each year of service. The credit for the plan and its success should be largely placed with the president of the company, Charles P. Foote, who has gained the complete confidence and loyalty of his entire organization.

New Notes

EDGE MOOR IRON CO. announces the removal of its Chicago office from 1543 First National Bank Building, to 1108 Otis Building, No. 10 South La Salle St., telephone, Franklin 4880.

AT A MEETING of the Avon Park, Fla., council, a franchise was granted to L. O. Feagin and associates, to put in a system of waterworks and operate an electric light plant, and work will begin right away.

REPORT OF the Westinghouse Electric and Manufacturing Co. for the fiscal year ending Mar. 31, 1914, shows earnings on the common stock of 10.29 per cent as against 7.86 per cent for the previous year, 5.89 per cent in 1912, 11.31 per cent in 1911 and 7.38 per cent in 1910. The total current assets are nearly $18,800,000, of which about one-third is cash.

THE DULUTH OFFICE of the H. W. Johns-Manville Co. has moved to larger quarters at No. 327 W. First St., in order to take care of its increased business. The new office is on the ground floor, with windows for the display of J-M asbestos roofing, pipe coverings, packings, sanitary specialties, auto accessories and other products of this company's varied lines.

SIR JOSEPH WILSON SWAN, inventor of the first incandescent electric lamp, died in London recently. He was 86 yr. old and was born in Sunderland, England. Having spent many years of his life in experimenting with electric lamps, he succeeded, in 1879, in solving the problem of producing an incandescent light and thus making possible the general use of electricity for lighting purposes.

AT ATHENS, OHIO, ground for the central power station of the Ohio Electric Power Co. was broken recently. The plant will be located at Floodwood, in the heart of the Hocking Valley coal mining district, and the company already has franchises in a number of Athens and Meigs County towns. Transmission lines to towns within a radius of 40 mi. are planned and Engineer Gampers, formerly of Columbus, declares the plant will be in operation in a few months.

THE NEXT annual meeting of the National Gas Engine Association will be held in Chicago, Ill., June 24, 25 and 26.

The following is a tentative program which is planned for this, the Seventh Annual Meeting to be held in the La Salle Hotel.

Wednesday, June 24, 10 a. m.

Meeting called to order.....President Oglesby
Minutes of last meeting.
Report of the Secretary.....H. R. Brate
Report of the Treasurer.....Otto M. Knoblock
President's Address .....Richard A. Oglesby
Appointment of Special Committees.

1:30 p. m.

Report of Insurance Committee.....
.....S. M. Walker, Chairman
Discussion.
Report of Freight Committee.....
.....C. O. Hamilton, Chairman
Discussion.
Report of Publicity Committee..H. W. Jones, Chairman
Discussion.

Thursday, June 25, 10 a. m.

Report of Standardization Committee.....
.....C. O. Kratsch, Chairman
Report of Pulley Section.....S. M. Walker
Discussion.

1:30 p. m.

Report on Horsepower Rating and Standard Brake...
.....Prof. P. S. Rose
Discussion.
Report of Show Committee.....
.....Albert Stritmatter, Chairman
Discussion.
Paper—"Heavy Oil Engines in the Small Units."
(Name of speaker will be announced later.)
Evening Entertainment Features.

Friday, June 26, 10 p. m.

Election of 3 Members of the Executive Committee.
Report of Farm Power Committee.....
.....Prof. P. S. Rose, Chairman
Discussion.
Paper—"Catalogs" .....
Prof. George W. Munro, Purdue University.
Discussion.

1:30 p. m.

Report of Cost Accounting Committee.....
.....C. B. Segner, Chairman
Discussion.
Paper—"Co-operating with and Assisting the Dealer"
G. M. Matson.

UNITED STATES CIVIL SERVICE COMMISSION announces an open competitive examination for senior highway engineer and highway engineer, June 29, to fill vacancies in the Office of Public Roads. The duties will involve superintending the construction of roads of various types throughout the United States, inspecting roads and investigating road building materials; administrative organization, methods of management, etc., for the purpose of reporting upon systems by which the best administration, construction, and maintenance of county systems may be secured; the giving of addresses at road meetings will also be included. Competitors will not be assembled for examination, but will be rated on the following subjects, which will have the relative weights

indicated: Education, and experience in highway engineering, 80; experience in other engineering lines, 10; experience in delivering lectures and addressing meetings, 10. Applicants for the position of senior highway engineer must show that they are graduates in civil engineering from a technical school or college of recognized standing, and that they have had at least 5 years' actual responsible experience in highway engineering work, both technical and practical, subsequent to graduation; or, if not graduates, that they have had not less than 9 years' actual responsible experience in highway engineering work, both technical and practical, or a combination aggregating 9 yr. Applicants for the position of highway engineer must have had at least 3 years' such experience subsequent to graduation, or, if not graduates, not less than 7 years' experience or a combination aggregating 7 yr. Applicants must have reached their thirtieth birthday on the date of the examination. In applying for this examination, ask for Form 1312, using the title, Senior Highway Engineer, Male ($2220 to $3000) or Highway Engineer, Male ($1800 to $2100).

UNITED STATES CIVIL SERVICE COMMISSION announces an open competitive examination for mining draftsman, on June 17 and 18, 1914, to fill a vacancy in this position in the Bureau of Mines, Pittsburgh, Pa., at an entrance salary of from $1080 to $1200 a year, and vacancies in positions requiring similar qualifications. The duties of the person appointed to this position will be to review the drawings of mines sent in by the mining engineers of the bureau, to revise, complete, and correct such drawings, or to reduce or enlarge them for the purpose of illustration in the printed publications of the bureau. The following subjects will have the relative weights indicated: Mining engineering (elementary questions of a practical character on mining engineering, 30; drawing (preparation of drawings suitable for publication from sketches, drawings, or descriptions relating to mines), 40; training and experience, 30. Age, 21 yr. or over on the date of examination. In applying for this examination, ask for Form 1312, using the title, Mining Draftsman (Male).

UNITED STATES CIVIL SERVICE COMMISSION announces open competitive examinations for the following on July 8, 1914: First-Class Steam Engineer (Male) in the United States Penitentiary, Atlanta, Ga., at $1200 a year; Landscape Architectural Draftsman (Male), in the Engineer Department at Large, War Dept., Washington, D. C., at $900 a year; Assistant Physicist (Male), (Qualified in Metallography), in the Bureau of Standards, Dept. of Commerce, Washington, D. C., at $1400 to $1800 a year. In applying for these examinations, ask for Form 1312.

WESTINGHOUSE ELECTRIC & MFG. CO. announces further changes in the Sales Department: F. N. Kollock, Jr., has resigned his position as District Manager of the Seattle office to accept the position of Treasurer and Assistant Secretary of the Westinghouse Lamp Co., Bloomfield, N. J.; W. D. McDonald, formerly Branch Manager of the Minneapolis office, has been appointed to succeed Mr. Kollock as District Manager at Seattle; C. C. Curry has been appointed Acting Branch Manager at Minneapolis to succeed Mr. McDonald.

W. E. S. GUYER, who has been actively engaged in Philadelphia and vicinity for several years, will devote his time to consulting engineering and architectural work, as applying to factories, mills, industrial buildings and power plants, with office at 1429 Land Title Building, Philadelphia, Pa.

W. A. THOMAS, who for several years past has been Commercial Engineer in charge of all sales of mining apparatus for the Westinghouse Electric & Mfg. Co., with headquarters at East Pittsburgh, resigned his position with this company on June 1, and has taken up the practice of consulting engineering in Pittsburgh, with offices in the Second National Bank Building.

Mr. Thomas graduated from Penn State College in 1898 and was connected with the General Electric Co. at Schenectady, going through the Testing Department and afterwards was connected for several years with the power and Mining Engineering Department. For 2 yr. he was in charge of the power equipment of the Pennsylvania Coal and Coke Co., at Cresson, Pa., resigning his position with this company to take charge of the mining work of the Westinghouse Electric Co., as above mentioned. He will specialize on mining.

ELLIOTT CO., PITTSBURGH, PA., has now completed the removal of its manufacturing department, including all its tools and equipment, to its new Jeannette works. During the past year the company has been busily engaged in remodeling and adding to its Jeannette property, including a substantial addition to the power plant and erecting shop. The present new machine shop has about 4 times the capacity of the Pittsburgh plant, and in addition there is a large erecting shop, 200 by 120 ft., for taking care of the larger apparatus.

The new plant has been equipped with labor-saving apparatus to reduce labor to a minimum. Power is furnished from a central plant and distributed electrically, all large machine tools being direct motor-driven. The plant is fully equipped with large traveling cranes, hoists, and various other equipment to facilitate the handling of material.

The work on the new 250 by 150-ft. foundry is progressing and will be completed later in the season. This new plant of the Elliott Co. is located on a 33-acre plot adjacent to Jeannette, Pa., with excellent shipping facilities; but the general office of the company will as heretofore be located in Pittsburgh.

UNITED STATES CIVIL SERVICE COMMISSION announces an open competitive examination for mechanical draftsman, on June 17 and 18, 1914, to fill a vacancy in this position at $1000 a year, in the Patent Office, Department of the Interior, Washington, D. C., and vacancies as they may occur in positions requiring similar qualifications.

The following subjects will have the relative weights indicated: Arithmetic (including common and decimal fractions, proportion, etc.), 5; lettering and shading, 20; isometric projection, 20; drawing and specifications, 35; training and experience, 20. The drawings required to accompany specifications for patents in the United States Patent Office are made on 3-sheet bristol board 8 by 13 in., in india ink, and the drawing tests in this examination will be similar to Patent Office drawings.

A copy of "Rules and Practice in the United States Patent Office," wherein further details of the drawing requirements are given, may be obtained free by writing the Commissioner of Patents, Washington, D.C. Age, 18 yr. or over on the date of the examination.

In applying for this examination, ask for Form 1312, using the title, Mechanical Draftsman (Male).

Books and Catalogs

McAndrew's Floating School, by Captain C. A. McAllister, 1914, 250 pages and 37 illustrations; price $2.00.

Without realizing that he is doing so, the reader of McAndrew's Floating School, is perusing an elementary text on marine engineering. This is brought about by letting the student feel as though he was reading an interesting and amusing story written expressly for engineers. While little pictures of human nature are here and there interwoven, the bulk of the subject matter, which is applicable not only to marine work but to stationary engineering as well, includes elementary mechanics, heat and combustion, boilers, engines, feed water appliances and electricity. The closing chapters deal with piping, indicators, care and management of boilers and engines and conclude with a list of examination questions and answers.

The book as a whole, though, as before stated, elementary, very well fills its purpose in the hands of the man who cares to prepare himself for the examination required of licensed engineers.

Bureau of Mines is issuing the following new publications, only a limited supply of which is available for free distribution, and applicants are asked to co-operate in insuring an equitable distribution by selecting publications that are of especial interest.

Bulletin 57: Safety and efficiency in mine tunneling, by D. W. Brunton and J. A. Davis, 1914; 298 pp., 6 pls., 45 figs.

Bulletin 79; Abstracts of current decisions on mines and mining; March to December, 1913, by J. W. Thompson, 1914; 140 pp.

Technical Paper 35: Weathering of the Pittsburgh coal bed at the experimental mine near Bruceton, Pa., by H. C. Porter and A. C. Fieldner, 1914; 35 pp., 14 figs.

Technical Paper 62: Relative effects of carbon monoxide on small animals, by G. A. Burrell, F. M. Seibert, and I. W. Robertson, 1914; 23 pp.

Technical Paper 72: Problems of the petroleum industry; results of conferences at Pittsburgh, Pa., Aug. 1 and Sept. 10, 1913, by I. C. Allen, 1914; 20 pp.

Technical Paper 74: Physical and chemical properties of the petroleums of California, by I. C. Allen, W. A. Jacobs, A. S. Crossfield, and R. R. Matthews, 1914; 38 pp., 1 fig.

Requests for all papers can not be granted without satisfactory reason. Publications should be ordered by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D. C.

HOW NEARLY 1000 PLANTS Measure Boiler Feed, Condenser Discharge and Other Liquid Flow is the title of a recent folder from Yarnall-Waring Co., Chestnut Hill, Philadelphia.

KOERTING JET CONDENSERS are described in Catalog 5, Section AB, from Schutte & Koerting Co., 12th and Thompson Sts., Philadelphia.

BUCKEYE-MOBILES, manufactured by Buckeye Engine Co., Salem, O., are described and illustrated in Bulletin No. 111-B.

BULLETIN NO. A4200, issued by the General Electric Co., is devoted to strain insulators and strain clamps suitable for insulating and supporting power house wiring and overhead distributing cables and wires. The construction of these insulators and clamps is illustrated and described, and the bulletin contains also catalog numbers and prices of the various articles.

WITH A HIGHLY COLORED plate showing the interior of their foundry, Messrs. "Usines Carels Freres" of Ghent, Belgium, have issued an artistic pamphlet describing the history, working principle and various types of Carels-Diesel engines as manufactured by them. Various reproductions of photographs illustrate the application of their engines to both stationary and marine service in units up to 1500 b. hp.

MUNNING-LOEB CO., of Matawan, N. J., has just issued Bulletin 500, on its plating and industrial brushes. The book contains information on brush manufacture from the making of the block, selection and origin of stock to the final finish. Operating characteristics of the several brush materials and their adaptability to certain classes of work are briefly discussed. This bulletin may be obtained by writing to the company at the address given herewith.

A ONE-ACT PLAY entitled, Cooking Breakfast at the Table, has just been brought out by the Westinghouse Electric & Mfg. Co., the personnel of which is as follows: Toasty, a Westinghouse electric toaster stove; Perky, the Westinghouse electric percolator; Time O-Day, the Grandfather's clock; Mr. and Mrs. Thrifty, the exponents of Westinghouse electric ware, who have become known to the public through the Westinghouse moving pictures. The play consists of one scene and describes the preparation of breakfast by Mr. and Mrs. Thrifty with the Westinghouse devices which themselves take part in the discussion as to their relative merits.

TESTS OF BOND Between Concrete and Steel, by Duff A. Abrams, has just been issued as Bulletin No. 71 by the Engineering Experiment Station of the University of Illinois.

In designing structures of reinforced concrete, it is important to know the amount of stress which may be developed between the surface of the reinforcing bars and the surrounding concrete before failure is produced by the slipping of the bars. This stress is what is commonly termed "bond." The above-mentioned bulletin gives the results obtained by pulling out bars embedded in blocks of concrete, and also the results of tests made to study the bond stresses developed in large reinforced concrete beams. Nearly 2000 tests are reported and a wide range of conditions are represented. This is one of the most exhaustive studies of the amount and distribution of the bond stress between concrete and steel which has appeared.

Copies of Bulletin No. 71 may be obtained gratis upon application to C. R. Richards, Acting Director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

CATALOG NO. 9, describing Smith producers for bituminous coal, was recently received from the Smith Gas Power Co., of Lexington, O.

PORCELAIN AND GLASS Insulators are thoroughly described and illustrated in Catalog Section DS845 just issued by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The booklet gives a large number of sectional drawings with the voltage ratings. The different kinds of insulators such as the Pin type for poles, Pin type strain insulators, transformer bushings, roof entrance bushings, outdoor type transformer bushings, floor and wall tubes and knobs, are all covered.

Trade Notes

YARNALL-WARING CO., Chestnut Hill, Philadelphia, reports orders from the Cleveland Electric Illuminating Co., Cleveland, Ohio, comprising in all, 72 2½-in. Simplex valves.

THE LEA RECORDER CO., of England, has just received an order for 11 Lea meters, 7 for measuring condensate and 4 for measuring boiler feed, from the London and Southwestern Railway Co., London, England.

THE MURRAY IRON WORKS CO., of Burlington, Iowa, has bought the property adjoining its Corliss Engine Works, which was formerly occupied by the McCosh Iron & Steel Works. This gives the Murray Iron Works Co. about 10 acres in the heart of the town, adjacent to its former plant, besides the foundry at West Burlington.

AN INTERESTING special type of dump car, for hauling coal from storage to boilers, has recently been devised by the Orenstein-Arthur-Coppel Co., for the Bertha Mining Co. This car dumps part way over, remaining in such position that the material can easily be shoveled out when firing the boilers. While loading, the car remains in normal, upright position. It has flangeless wheels and swiveled front axle with handle so that it can be pulled over the floor in any direction.

WHILE THE USE of wood bearings is quite old, and the use of wood impregnated with oil has been known for many years, yet the introduction of graphite for the impregnation of wood is comparatively recent, and has been found to overcome the difficulty from oozing out of oil and grease in such bearings. This impregnation with graphite has been embodied in the Nigrum oilless bearing, manufactured by the Graphite Lubricating Co., and avoids the sticking of the shaft after a period of idleness; also, does away with the gumming up from grit and dirt.

WESTINGHOUSE ELECTRIC & MFG. CO. reports the following orders received for paper mill equipments:

S. D. Warren & Co., West Brook, Maine, 5 150-hp., 315 r.p.m. motors for driving Jones' Jordans; J. E. Henry & Sons, Lincoln, N. H., 1 125-hp., 375 r.p.m. motor for driving a Jones' Jordans; West Virginia Pulp and Paper Co., for 2 3500-kw., 3-phase, 440-volt, 25-cycle, 1500 r.p.m. turbo-generator outfits complete with Westinghouse Le Blanc condensers to be installed at the Piedmont, W. Va., plant.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

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Full page, one year, each insertion, $60.00.

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Other specified positions, regular rate plus 10 to 50 per cent.

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Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 23,500.

Technical Publishing Co.
537 S. Dearborn Street
Chicago

Position Wanted

POSITION WANTED—Age 23. Have had 4 years running Oil and Gasoline Engines; 2 years House Wiring for Electric Lights, Old and New work. Good mechanic. Gilbert R. Osborne, Edgartown, Mass. 6-15-1

POSITION WANTED—As Chief Engineer in Institution, with 10 years' experience in Institution work. Can give best of reference. C. H. Mitchell, 1403 Congress St., Portland, Maine. 6-15-1

POSITION WANTED—In Stationary Plant by Marine Engineer. Holds U. S. Government Marine license. Six years Marine and 2 years Stationary experience on A.C. and D.C. Generators, high and low speed engines. Age 24. Married. Best of reference. Address, Box 350, Practical Engineer. 6-15-2

POSITION WANTED—Engineer with Ohio license wants steady position, experienced with A.C. and D.C. current. Do not use Liquor or Tobacco. Age 26. Can furnish references. F. J. C., 7206 Harvard Ave., Cleveland, Ohio. 6-15-1

POSITION WANTED—By industrious and capable young man as engineer in power station. I. C. S. graduate. Five years' experience on large reciprocating units and large steam turbines. A.C. and D.C. apparatus. At present, engineer in large power station. Chicago license. A1 references. Address Box 347, Practical Engineer. 6-15-1

Wanted

WANTED—A small ice-making and refrigerating plant with a daily capacity of about 10 to 15 tons is wanted by a subscriber. A second-hand plant preferred. Give full particulars. Address, Box 341, Practical Engineer. tf.

WANTED—Every local Engineers' Association to have an assortment of valuable power-plant books—Secretary, write at once, for full particulars. Address, Dept. C, Practical Engineer, Chicago.

IF YOU ARE a night engineer, spend a few hours each day taking subscriptions for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once.

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED—Secretary of local Engineers' Association to write at once in regard to a very interesting proposition. Address Practical Engineer, Circulation Department.

Help Wanted

HIGH CLASS SPECIALTY SALESMAN—We desire correspondence with a specialty salesman or representative who has the requisite qualifications both as to salesmanship and general knowledge of engine-room and boiler-room equipment, to intelligently present our line to the Engineer, Consulting Engineer, Superintendent and Manager. We manufacture 6 high-grade mechanical boiler and engine-room specialties (no small articles). Are well advertised; our products are in use in a great number of representative plants, and some of them at least are generally recognized as the "standard" in their field. We would be interested only in men of proven selling ability, who can present unquestionable references covering both selling ability and character, and prefer correspondence from men who have had sufficient experience in the power-plant field to enable them to conclude with some reasonable degree of accuracy whether or not they could sell our goods after seeing what there is to offer. Our products are sold on trial when desired, and arrangement with salesman is on a very liberal commission basis with a liberal advance on receipt of order. If you write—say something—don't merely give your name and address and ask for information. Address, Box 351, Practical Engineer. 6-15-1

WANTED—An additional subscription solicitor wanted to cover towns in the State of Oklahoma. Excellent chance to earn extra money. Write to Subscription Department. tf.

For Sale

TRAVELING CRANE—Wooden—For Sale Cheap. 15-ton capacity, 65-ft. span, suited for either motor or wire rope drive. Write Box 346, Practical Engineer. 4-15-6

FOR SALE—16 by 36 Hughes & Phillips Corliss, with wheel 12 ft. by 19 in., perfect condition, overhauled, $550. 100-kw., G. E. type, "ATB," rev. fld., 3-ph., 60-cyc., 220-volt alternator, with exciter and switchboard, $550. Also 17 by 24 Erie City, 4-valve engine, $750. Duzets & Son, 50 Church St., New York. tf.

FOR SALE— 2 Buckeye steam engines at bargain prices. 1 12 by 21-in., 85-hp., 185 r.p.m., 85-lb. steam pressure, flywheel 6 ft. diameter, 22-in. face. One 11 by 18-in., 70-hp., 200-r.p.m., 85-lb., steam pressure; flywheel 4 ft. diameter, 14-in. face. Changed to motor drive. Must move at once. Write today. The W. H. Mullins Co., Dept. A, Salem, Ohio. 4-15-6

FOR SALE—One 95-hp., 3-cylinder Westinghouse producer gas engine and complete equipment for operating suction type. Constant use one year. Practically new. Address, Box 345, Practical Engineer. 4-15-6

Patents and Patent Attorneys

PATENT YOUR INVENTION. Send sketch for free expert search and report as to patentability. Books on inventions and patents, and book of references from congressmen, manufacturers, bankers and inventors sent free. John S. Duffie & Co., 612 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY. Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman, Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact cost. Send for full information. tf.

OFFICIAL DRAWINGS FREE. Patents procured or fee returned. Expert services. Send sketch for Free search. The Patent Exchange, Garban Bldg., Washington, D. C. tf.

FOR HONEST advice and real patent at Low Cost, consult John O. Seifert, Patent Attorney, 50 Church St., New York. 5-15-6

PATENTABLE IDEAS WANTED—Send for 3 free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

PRACTICAL GUIDE FOR INTERIOR WIRING. Gives real "dope" on wire sizes and conduits for light and power without figuring. Ten cents. J. Wilmore. 687 Wales Ave., New York City. 6-15-1

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in NEW subscriptions (not your own) to Practical Engineer. Gilt edges; bound in leather.

Miscellaneous

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you. tf.

Sparks From The Advertising Pages

In a recent magazine article, Elbert Hubbard tells about a day spent with John D. Rockefeller. The following are the first paragraphs of his article:

"Not long ago I had an engagement to play golf with John D. Rockefeller at nine o'clock in the morning. Arriving at the golf grounds on the minute, we had no more than climbed out of the automobile before Mr. Rockefeller arrived on a brand-new bicycle. His first words were: 'On schedule, boys, on schedule! That's the thing!' And he leaped off his machine as lightly and easily as might a boy of twenty.

" 'Been wasting some of your hard-earned money,' said I, pointing to the new bicycle.

" 'Yes, I am getting extravagant,' said Mr. Rockefeller. 'That wheel cost me just fifteen dollars. I saw them advertised and sent one of my boys down with the money. Twenty-five years ago that wheel would have cost one hundred dollars. And yet they talk about the high cost of living! Some things are higher, of course, but others are not. And as some one has said, 'If it costs more to live today than ever before, is it not worth the money?' "

This ought to hand a jolt to the fellow who is holding down a two-by-four job somewhere and says that he is too busy to read the advertisements. When one of the richest men in the world finds it to his advantage to look through the advertisements before purchasing articles for his daily use, he leaves little excuse for the average man to claim that "it takes too much time."

* * *

We met a friend of ours the other day,—an engineer—and after the few usual commonplace remarks about ball teams and hot weather, the talk turned to the subject of power plant advertising. In the course of conversation he dropped this remark: "One fault I find with many advertisements in the power plant papers, I get, is that they are written so that it takes study to understand them. The kind I read, mostly, are those that are easy to read and understand, for I get all the studying I want over the diagrams and articles in the editorial sections."

This was a new idea to us, so we didn't have much to say about it. We wonder if any of our readers have. If you have found expressions in advertisements in Practical Engineer which were hard to understand, write and tell us about it. We will be interested in your letters. If you can quote the sentence and the advertisement, so much the better. A letter from you may help an advertiser correct a fault of which he has been unaware.

* * *

Referring to the cost of advertising, the J. B. Williams Co., manufacturers of shaving soap, now put up their shaving sticks more attractively and conveniently, with 20 per cent more in the containers, than twenty years ago. Dealer buys at 2 per cent less and has freight prepaid, where he formerly paid it himself. Advertising appropriation for shaving sticks much larger than twenty years ago.

The consumer gets more for his money, the dealer buys for less, railroads carry more freight, the publishers sell more space. *Who loses?* Advertising is a regular little Santa Claus when it comes to doing good to everybody.